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SIR FRANCIS WATTS.

THE death of Sir Francis Watts closes the career of one of the most prominent pioneers in the application of scientific methods to the growing of tropical crops and to the manufacture of plant products from them. Sir Francis Watts commenced his work in the British West Indies at a time when stimulation of the beet-sugar industry by bounties had so reduced the price of muscovado cane-sugar that the industrial situation in the sugar-producing islands had become almost hopeless. After serving as Chemist to the Montserrat Company from 1883 to 1889, Sir Francis (then Mr.) Watts assumed charge in January, 1889, of the newly-established Government Chemical Laboratory at Antigua. One of his first investigations was a thorough study of the then prevalent field and factory methods of the cane-sugar industry. He soon convinced himself of the wastefulness of the small factory system. In various reports and papers, and in his *Manual for Sugar Growers*, Watts exposed the deficiencies of the existing practices, and suggested a remedy in the erection of large, scientifically-managed, central sugar factories. The idea received enthusiastic support from sugar-planters in Antigua, but much discussion arose as to whether the factories should be controlled by Government or by private enterprise. Largely owing to Watts' commercial acumen, an agreement was at least reached between a group of British capitalists (aided by the Government), and the Antigua estate owners, whereby the growers undertook to supply canes for a period of 15 years, at a price based on current market values. In addition, they were to receive a share of the profits of manufacture, and ultimately a half-share in the factory itself. In 1905, the Gunthorpe's Central Factory commenced operations. The output during the first few years was some 3,000 tons of sugar per annum, but it rapidly rose by the end of the 15-years period to nearly 10,000 tons; the results proving highly satisfactory to planters and factory owners alike. It is interesting to record that the contract under which this agreement worked was so wide in scope that, during the whole 15-years period of its application, not one instance of disagreement was submitted to the courts for settlement.

The benefits of the central factory system in Antigua soon induced the establishment of similar co-operative factories in St. Kitts, Jamaica, Trinidad and Barbados. Watts lived to see the whole sugar-cane crop of St. Kitts, which in 1928

amounted to 20,000 tons of sugar, manufactured in one central factory, and all the crop of Antigua manufactured in two factories, Gunthorpe's and Bendal's, the former of which in 1928 made 17,088 tons of sugar at the rate of 7.63 tons of cane to one ton of sugar, and the latter, 2,580 tons of sugar. The success of these factories naturally exerted a favourable influence on the welfare of the sugar-producing islands. It is a striking testimony to Sir Francis Watts, that, having accomplished so much at the very beginning of his career towards the amelioration of the conditions of the British cane-sugar industry in the West Indies, he should have again been called upon to study its problems in another insular community, Mauritius, as a last service to a cause which always commanded his sympathy.

Whilst in Antigua, Watts' attention was not directed solely to sugar. He interested himself also in the improvement of the cacao crop in the Leeward Islands, by inaugurating in 1901 a series of classical manurial experiments in Dominica, and in the development of the citrus industry, by indicating how losses in the manufacture of concentrated lime-juice could be avoided, and how further savings could be effected by converting the acid of lime-juice into readily-marketable calcium citrate. Whilst engaged in studies of citrus products, Watts discovered an interesting compound, limettin, which proved to be a normal component of the essential oil of lime-rind. The constitution of this substance was subsequently elucidated by Sir William Tilden, his former teacher at the University of Birmingham. Watts' further contributions to the chemistry of essential oils included an investigation into the composition of bay-leaf oil and the effects of cultivation and methods of distillation on bay-oil production. In these various activities, Watts was ably assisted by officers of his own department, and of the various botanical stations within the Leeward Islands. His achievements earned for him in 1904 a Doctorate in Science at the University of Birmingham.

Apart from his interests in tropical crop products, Dr. Watts made a special study of soil problems. In this domain also he was undoubtedly a pioneer. He was one of the first to inaugurate investigations on soil colloids, and the application of mineralogical chemistry to questions of soil fertility. He initiated soil surveys in Dominica (1903), Montserrat (1906), Nevis (1909), and Antigua (1916), at a time when the new notions announced by Dr. Milton Whitney in the United States of America were just beginning to affect the scientific study of soils in other countries. Dr. Watts' enthusiasm for soil science in its various theoretical and practical aspects remained unabated to the end of his life.

When the Imperial Department of Agriculture for the British West Indies was established under the directorship of Dr. (afterwards Sir Daniel) Morris at Barbados in 1898, the Antigua Laboratory became a federal institution under the new scheme, and Dr. Watts, after a brief period of duty in Jamaica, was created, in 1899, Government Chemist and Superintendent of Agriculture for the Leeward Islands. He retained this position until January, 1909, when he was appointed Imperial Commissioner of Agriculture for the British West Indies in succession to Sir Daniel Morris. In that year, Dr. Watts severed his long connection with the Leeward Islands, and took up his residence in Barbados. Nevertheless, he still continued to maintain a close contact between the chemical laboratory and the various insular agricultural and botanical stations under his jurisdiction.

During the early years of the work of the Imperial Department of Agriculture, the introduction of Sea Island Cotton was an important feature of the agriculture in most of the West Indies Islands, and Watts contributed a large share to the considerable success that attended those early efforts.

Furthermore, he played an active part in the promotion of scientific education in West Indies agriculture by means of the establishment of industrial schools and through the publication of numerous articles on agricultural training. His book *Nature Teaching*, first published in 1901, reached its fifth revised edition in 1925, and still commands a wide circulation. The Conferences of the Imperial Department of Agriculture, originally organized by Sir Daniel Morris, and conducted later by Sir Francis Watts, were educational in character, and from the first, Sir Francis was regularly a delegate, and always took a prominent part in discussions.

In 1917, Dr. Watts received the merited honour of knighthood. At this period of his career, Sir Francis Watts' duties were almost entirely administrative. His chief interest, however, now lay in the realization of an object which had occupied his mind for some years, namely, the establishment of a College of Agriculture in the British West Indies. He persistently pressed for the consummation of this idea. In spite of many difficulties, a College Committee was eventually appointed in 1919, by the Right Hon. Viscount Milner, then Secretary of State for the Colonies. As an outcome of the recommendations of this Committee, plans for the founding of a college in Trinidad were eventually approved. Through the generosity of the Government of Trinidad and Tobago, a site at St. Augustine was presented to the newly-constituted Governing Body, and The West Indian Agricultural College came into being in October, 1922, with a teaching staff comprising four officers of the Imperial Department of Agriculture, with Sir Francis Watts as Principal. The first year's enrolment of students numbered thirteen. Subsequently the scope of the College was greatly widened, by the inclusion of post-graduate courses for men selected for service in tropical Colonies of the Empire. In 1923, the name of the College was changed to the Imperial College of Tropical Agriculture, and in 1926, the grant of a Royal Charter was obtained.

Sir Francis Watts successfully presided over the inauguration and progress of the College during the difficult years of its early development. In

1924, at the age of 65, he retired from the position of Principal, having witnessed the successful realization of his schemes. Subsequently, he resided in close proximity to the College. His wide experience and profound knowledge of agricultural science, particularly in relation to West Indies conditions, were still available, and, as Principal Emeritus, his interest in the progress of the work of the institute which he did so much to foster, was always actively sustained. In other ways, Sir Francis Watts proved a great asset to the Colony. He was elected in 1928 to the presidency of the Agricultural Society of Trinidad and Tobago, and also to that of the Horticultural Club. He served on a Committee organised to arrange prices for farmers' sugar-canes; he was a prominent member of the Froghopper Investigation Committee, and in a great many other ways, his services were constantly in demand by all sections of the agricultural community. In 1927-28, Sir Francis Watts attended the Congress of Federated Chambers of Commerce held at Capetown, Union of South Africa, as a representative of the West Indies Chamber of Commerce and of the College. On his return to Trinidad in February, 1928, he was elected a member of the Trinidad Legislative Council. In 1929, he was appointed by the Secretary of State for the Colonies to inquire into the conditions of the sugar industry of Mauritius. The results of his inquiries are contained in a Report written in December, 1929, and published in London in March, 1930. Sir Francis Watts returned to Trinidad from Mauritius and England on 9th August. His health had obviously suffered from the severe strain which his long voyages and his numerous activities had imposed. His condition gradually became worse, and he died at his residence at St. Augustine on 26th September, after a brief illness.

During his life, Sir Francis Watts was closely associated with men who, like himself, have added to the prestige of the agricultural worker, and have made valuable contributions to the application of scientific methods. To mention the West Indies only, he was closely associated with Dr. C. A. Barber, Sir Daniel Morris, Mr. John R. Bovell, Sir Henry A. Nichols, and Sir John Harrison. Among the younger generation of agricultural workers in various parts of the Empire, many agricultural officers now holding responsible positions, owe their early training and their youthful enthusiasms in agriculture to the kindly encouragement and geniality of Sir Francis Watts. Among the students who have passed through the College, there exists a deep feeling of gratitude towards its first Principal for that strength of purpose and farsightedness which have made possible its rapid development.

Regret at our common loss and sympathy to the bereaved family will be universally shared, but will ever be coupled with a feeling of thankfulness for a life of outstanding ability, a genial and kindly personality, and great accomplishments in the field of science.

THE HURRICANE IN DOMINICA.

THE following note which relates to the hurricane is based on a despatch recently received from the Agricultural Superintendent. An accurate estimate of the damage at the time when the despatch was written was impossible. It is stated, however, that 75 per cent. of the coconut crop and 30 per cent. to 50 per cent. of the lime crop were destroyed while the late cocoa crop was almost completely destroyed. The loss on the lime crop was fortunately reduced by a long spell of dry weather which this year was responsible for the earlier re-opening of this crop. The permanent damage to bearing cultivations was difficult to assess but it is probable that a large percentage of the damaged trees will recover. The lime industry has received a serious blow and it is anticipated that crop production for the next three or four years will fall to a very low figure and still be dependent on seedling trees which have escaped severe hurricane damage and disease. It is reported that once again the sour orange stock has stood up well against the storm and that bearing citrus on this stock, now grown by the Agricultural Department have not suffered appreciably beyond part loss of the crop. No extensive damage was done to the young budded lime plants in the nurseries and provided the young plants recover from the shaking they have received, it will be possible for the Department to supply approximately 25,000 of these plants.

It is felt that many planters will require financial assistance to re-habilitate their estates as much damage has been done to cultivations and particularly to estate buildings. As it is unlikely that much assistance will be forthcoming from the Banks or even from the Loan Board on account of the many catastrophies which have been experienced in the last five years through disease and hurricanes, it is suggested that some system of agricultural credits should be devised to assist the planters who, through continued adversity, are no longer in a position to put up further security to warrant bank loans for the restoration of their estates.

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Note.—The recent storm in Dominica will have the effect of clearing the way for the replacement of seedling limes with budded material. The loss of crop in this and the next few years will be considerable, but many of the old seedling trees which were dying of red root disease have been destroyed and the replanting will be done with budded limes. The strong root system of the sour orange makes it possible for the trees to withstand the terrific winds of these tropical storms. Mr. Joseph Jones in the Report on the Agricultural Department, Dominica, 1914-15 stated the need for budding as a safeguard against root diseases and that a three-quarter acre plot of spineless limes on sour orange stock was established in the Lime Experiment Station. These trees withstood the storm of 1928, but the plot had been cleared before the storm of last month.

H. A. B.

SUGAR-CANE BORERS.

The Control of *Diatraea saccharalis* in Barbados by mass liberations of *Trichogramma minutum*.

By R. W. E. TUCKER, M.A., B.Ed.

IN *Tropical Agriculture*, Vol. VI, No. 8, pp. 224-226, a short account was given of initial work on parasitic control of cane moth borer in Barbados. Results are now available of the effect of continuous mass liberation of *Trichogramma* on this pest, as shown by an analysis of the crop reaped in 1930, and these results, together with some of the more important observations made, and difficulties encountered, are given below.

Loss due to *D. saccharalis*.

This falls under three main heads:

(1) Damage to first growth of cane up to end of dry period (June-July).

(2) Damage to young shoots or tillers during main period of stool formation in wet season (July-October).

(3) Damage to maturing canes (October-February).

Estimates of this loss were made in the field, in cane delivered in factory yards, and in the laboratory. The figures so obtained show not only the serious damage wrought by the pest, but provide an idea of the results obtained by the 1929 mass liberations of parasites.

An independent estimate of the field loss or reduction in crop under head (2) was made by Dr. A. E. S. McIntosh, geneticist to the Barbados Department of Agriculture, who worked out during 1929 the actual reduction in crop due to tillers or young shoots which were killed by moth borer, and so prevented from maturing into reapable canes.

His estimate was 25 per cent. of the crop in the rainy area, and 20 per cent. in the dry area of the Island, or an average of 22½ per cent. This loss due to killing of potential canes, together with loss due to canes which mature but are severely damaged, or caused to break before reaping, by moth attack, would make a total of well over 12 tons per acre. This corresponds well with the estimate of 12½ tons of cane lost per acre, made by the writer and the Departmental field staff.

To this must be added the loss to factories due to the lowering of purity and sucrose content of juice in bored cane, the figures for which are given on page 293.

Control of *Diatraea* by *Trichogramma*.

Trichogramma minutum occurs normally as an egg parasite of *D. saccharalis* in Barbados, but is only capable of exerting a late and partial control, for the following reasons:

(1) It must be preceded by infestation of *Diatraea* in order that the medium for it to breed in may be available.

(2) This infestation must reach damaging dimensions before there are sufficient *Diatraea* eggs to attract and maintain the *Trichogramma*.

(3) The life cycle of the parasite is eight to nine days; that of the host (other than in the egg stage) is 30 to 31 days. It follows therefore that unless infestation by *Diatraea* is extensive enough to give a fairly continuous succession of broods and of egg deposition, the parasite cannot survive the full period between *Diatraea* broods in any one field.

(4) The parasite therefore cannot exert an *economic* control under natural conditions, for it cannot overtake its host until the canes have been riddled with borers sufficient to provide the parasites with adequate medium in which to breed.

The writer has, moreover, found that *Diatraea* larvae are wind borne and can spread perhaps even more rapidly from an infested centre than the parasite can. Adverse weather conditions were also shown to affect the parasite more than the host; in every way therefore the host *Diatraea* is normally in a stronger and more favoured position than the parasite *Trichogramma*.

Mass-breeding and liberation of *Trichogramma* in numbers and at seasons in advance of nature, minimise or remove all the above disadvantages.

The egg parasite *Prophanurus alecto* is also present in Barbados, and in some areas of the Island it is present in noticeable numbers in the early part of the season. It is not however as widely spread throughout the Island as is *Trichogramma*, is more seasonal in its operation, and is not known to be amenable to mass breeding in the laboratory. This parasite has not therefore been taken into account; no other parasites, larval or pupal have yet been found in the Island.

Mass Breeding Operations.

Methods of breeding and distributing *Trichogramma* have been evolved to suit local or West Indian conditions; difficulties due to the same conditions were also experienced, and are detailed below. Glass tubes one inch in diameter and six inches long were used as breeding units, each one accommodating two sheets carrying an average of 2,000 eggs apiece. The use of these standardised sheets divided into sections each bearing a known average number of eggs, facilitated both breeding operations, computations of numbers bred, and distribution in the cane fields. An eightfold increase was maintained as a daily routine; parasites were always allowed to emerge from the stock slips in the tubes (capped with gauze, secured by elastic bands) and to mate before the sheets of fresh eggs were introduced. The parasites lived in the tubes for two to three days, and parasitism was invariably high. Scrupulous cleanliness in these tubes was always maintained as any deviation from this resulted sooner or later in extensive mortality of *Trichogramma* before oviposition. The normal temperature and humidity of the climate of Barbados are suitable for breeding *Trichogramma* and its host moth *Sitotroga* throughout the year, the only adjustment needed being the use of electric fans during the four hottest months.

The method of parasite distribution was given in *Tropical Agriculture*, Vol. VI, No. 8, and has proved very successful. The largest number of parasites distributed in any one month in 1929 was 6,349,000, the total liberation for the year being 22,816,700. In 1930, with additional equipment, it is hoped to reach over ten million per month, and to distribute a total of 50 to 60 million parasites.

Similar work in the control of *Diatraea* by means of *Trichogramma*, though apparently on a smaller scale, has been carried out in Louisiana, U.S.A., by Hinds and Spencer in 1928 and in 1929. Their results are summarised in *Jl. Econ. Ent.*, Vol. XXII, p. 633 and Vol. XXIII, p. 121, and in both years' work they report definitely favourable results in lowering of infestation and increase in crop yield due to the use of *Trichogramma*. They state definitely, moreover, that "colonizations with large numbers of parasites (94,000) in a limited area were not superior in results to colonizations with smaller numbers (10,000)"; and that "when large numbers of parasites are available it is deemed better at present to distribute them well over the area selected in increments of two or three thousands to a small section. It seems preferable to liberate on several successive dates rather than at one time only." This is precisely the policy which has independently been carried out in Barbados, and which, from the results already obtained promises to give a satisfactory and eminently economic control of *Diatraea* in Barbados.

Results obtained in 1930 crop from 1929 liberations.

The reduction of the amount of moth borer present in cane, and of the damage done by it in 1930 compared with 1929, can be seen from the following figures:

EXPERIMENT.	1929.	1930.
* Estimate of complete loss of cane in the field ..	31 %	20.85%
Total of canes badly bored at four factories	55 %	19 %
Total of canes *untouched* by borers at four factories ..	9.5%	27.5 %
Average weight of canes at four factories (over 2,500 canes weighed in 1929 and over 5,000 in 1930)	4.05lb	4.77lb.

* These figures are obtained by completely removing the trash from all the canes in 50 stools, and counting the number of shoots killed, and canes which have died due to moth borer attack, and estimating their weight together with the loss in weight of canes which are reapable, but damaged. This part of the investigation was carried out on four different plantations by field officers well experienced in such work.

With regard to the average increase in weight of nearly three-quarters of a pound per cane, this may be in part due to the simultaneous partial control of root borer *Diaprepes abbreviatus*, or to climatic conditions, though as far as is known to the writer, the latter were not particularly favourable to cane production in 1929.

Further evidence of the effect of the *Trichogramma* liberations on *Diatraea* is furnished by collections and counts made of *Diatraea* eggs in the cane fields. Collections were made at fortnightly intervals from the same portions of fields (which were originally selected at random), and each collection was made by the writer during a timed period of one hour. Fairly standardised results were thus obtained, giving moth prevalence, as shown by the number of eggs collected, and the extent of parasitism thereof. Altogether 47,700 eggs were thus examined in 1929; the collections in 1928 were not so standardised, but comparisons of figures obtained at corresponding dates and fields in both years, show an average increase in 11.1 per cent. in parasitism during September, October and November in 1929, over 1928.

In addition to making counts and weighings of badly bored, slightly bored and unbored canes in factory yards in five different areas in the Island, a parcel of 100 pounds of the above groups was weighed out and taken to the Departmental Laboratory for analysis. The number of canes to each 100 pounds was counted; the bored and unbored joints in the first two groups were separated by cutting, and counted; finally, the unbored, slightly bored, and badly bored joints were milled separately and the juices analysed. The results showed that even with the lessened amount of borer present, a total of 38.5 per cent. of the joints were affected by borer. The figures of purity and sucrose are as follows:

Analysis of	*Purity of juice.*	*Sucrose.*
(*a*) Unbored cane joints ..	88.12	19.66
(*b*) Bored cane joints (average of figures for slightly as well as badly bored joints)	86.29	18.39

The loss of sugar in the factories is therefore still a considerable item, though factory managers were fairly unanimous in stating that borer was much less, and purity and sucrose higher in the 1930 crop than in former years.

At the present stage of one year's parasite work only, the writer does not claim that the results set out above are due solely to control by parasites; there is every indication that such is the case for, as far as is known, no other factors have come into play to reduce the amount of moth borer, and (save for root borer control) to increase the average weight of canes. At least another season's work is required to confirm and extend the results obtained. It can, however,

definitely be claimed that further progress should be made with the mass breeding and liberation of *Trichogramma*, and as stated above this is being done in Barbados.

Hindrances to mass breeding of *Trichogramma*.

Many of the setbacks experienced in 1928 were due to local conditions, but others are liable to happen anywhere and may be of interest to other workers.

(1) Local corn was first used, but owing to its not being kiln dried, it tended to turn mouldy in the breeding rooms and led to subsequent trouble and diminished efficiency of the moth units.

(2) Local *Trichogramma* did not take to breeding in *Sitotroga* eggs (two strains of *Trichogramma* apparently present) and much productivity of the moth units was lost whilst selecting an adaptable strain and obtaining supplies of *Trichogramma* from Louisiana, U.S.A.

(3) A predaceous Gamasid mite (*Seius* sp.) developed in great numbers in the moth units and destroyed large numbers of eggs and moths before being brought under control.

(4) The moth units, being constructed mainly of wood, warped somewhat, and as a result of this, and of attempting to recondition the unsuitable corn in (1), grain weevils and beetles, and the moth *Ephestia Kuhnellia* gained access to the units. This not only hastened the deterioration of the corn, but the *Ephestia* moths which were sucked by vacuum into the collecting tubes with the *Sitotroga* were a serious drawback. Their eggs are parasitised by *Trichogramma* but the *Ephestia* larvae which hatch out from such eggs as escape parasitism, promptly devour the rest of the eggs, parasitised and unparasitised, on the sheets. Several generations of parasites were lost or severely diminished in this manner.

(5) The Pteromalid *Habrocytus cerealellae* Ashm., which is a parasite of *Sitotroga cerealella* also gained access to the defective moth units and attacked *Sitotroga* to such an extent that the number of moths available for egg deposition was seriously reduced.

The most serious drawbacks were the predaceous mite, *Seius*, the moth *Ephestia* and the parasite *Habrocytus*.

When the mite was discovered, it was combatted at first by sweeping up all dead moths every day, and swabbing the floors and rack uprights with hot five per cent. carbolic acid solution. The use of sulphur dust in the trays of corn was contemplated, but trials of the effect on egg deposition and development of larvae of *Sitotroga* had to be made. In the meantime List, Daniels and Bjurman recorded the effective use of sulphur against the mite in similar work (*Jl. Econ. Ent.*, Vol. XXI, p. 940), and so the use of sulphur in the moth units was adopted without further delay.

So far as Barbados is concerned, the use of sulphur against the Gamasid mite (*Pediculoides* fortunately was not present) has been successful and no detrimental results due to subsequent repelling of *Trichogramma* from the eggs laid by the moths, have been noticed. (Repelling of parasites recorded by Alden in *Jl. Econ. Ent.*, Vol. XXII, No. 5, p. 822.)

It is true that occasionally an entire generation of *Trichogramma* would speedily die out in the breeding tubes and jars after very scanty parasitism of the *Sitotroga* eggs, but that was traced to lack of scrupulous cleanliness in the said containers; it was found necessary to sterilise and maintain in perfect chemical cleanliness all containers used for breeding purposes. It cannot be said that the use of sulphur in the moth units subsequently acted as a repellant to the *Trichogramma*; on the other hand, the omission of sulphur dusting in a new moth unit resulted in a crippling infestation of mites.

The moth *Ephestia* and the parasite *Habrocytus* were dealt with by hand crushing the adults in the moth units, and by killing the larvae of *Ephestia* on the sheets of maturing parasitised eggs. Later when these pests increased in the units to numbers beyond control, the two original units had to be abandoned, and a third unit built. This necessitated a cessation of mass breeding, and liberations of parasites had to be discontinued during July and August. In the restocking process, with one infested unit still in commission the reconditioned units again became infested, but to a lesser degree. To cope with this infestation, fumigation with hydrocyanic acid gas was resorted to. A sufficient dosage was given to kill all adults and young larvae of *Habrocytus* and *Ephestia*, but not the pupae of *Sitotroga*. By repeating such partial fumigation when necessary, the pests were kept under, and the production of *Sitotroga* moths maintained.

It is anticipated that by thoroughly overhauling the units and taking adequate precautions, that the above hindrances to moth production in 1930 will be obviated.

Future Measures against *Diatraea*.

These consist in endeavouring to secure the planting of borer free cane as an accepted plantation routine practice, and the liberation of from ten to twelve million parasites a month for at least six months during 1930, and in subsequent years as found necessary. At the same time *Lixophaga diatraea* has been introduced from Cuba and should it prove successful, it may be possible to diminish the mass liberation of *Trichogramma*, or to confine such liberations to periods when *Lixophaga* is not active. *Lixophaga* was kindly obtained and shipped to Barbados by Dr. J. G. Myers of the Empire Marketing Board.

Cost of Control Measures.

The cost of planting borer free cane, once established as a practice, should not amount to more than a few pence per acre, and would be offset by the better germination secured and the reduction in the amount of "supplying" usually required. In practice one planter found that rigid elimination of all "plants" touched by borer cost three-quarters of a cent (three-eighths pence) per hundred—a relatively negligible amount. The cost of breeding and distributing the parasites is remarkably low for a primary control measure. An average output of nine to ten million parasites a month would take, in Barbados, a capital outlay of £400 in equipment (vacuum producing engine not included), and a maximum maintenance outlay of £300 per annum, which includes salary of a competent assistant and all labour and material. Taking the life of the initial equipment as four years, then the annual cost of mass parasite breeding over this period can be put at £400 or less than three pence per acre of cane in Barbados.

CITRUS FRUITS.

THE 1930 outlook indicated, as did those of the four previous years, a considerable increase in the bearing acreages of oranges and grapefruit. Many trees now in bearing have not reached the age of maximum yield and a large increase in production may be expected in years when favourable growing weather prevails. The bearing acreage of lemons has not shown any pronounced change since 1921; a slightly downward trend is now indicated, but production is on a high level and the industry still is confronted with difficult marketing problems.

Of the total shipments of oranges in the United States about 66 per cent. move from November to April, inclusive. Practically all of the crop, except the California Valencias, move during this period. Assuming an average of 70 trees per acre, total orange acreage in Florida is estimated at 195,000, of which about 15 per cent. is non-bearing. Under more favourable conditions than have prevailed in recent years a material increase in production may be expected. Texas, with an acreage of 18,900, has only about 25 per cent. in bearing. As contrasted with the situation in Florida and Texas, California Washington Navel production has probably reached its peak. Only three per cent. of the 100,500 acres of Washington Navels are classified as non-bearing. A further increase in bearing acreage and production of California Valencias is expected. Of the total acreage of 112,200 acres, 20,900 acres, or 19 per cent., are classified as non-bearing. During recent years there has been a marked upward trend in both production and prices of California Valencias which indicates a substantial increase in the demand for them. This upward trend in demand is expected to continue but at a slower rate.

The importance of an export outlet for California Valencias in years of large crops was demonstrated last year. During the 1928-29 season over 1,500,000 boxes of oranges were shipped to foreign markets, exclusive of Canada. Most of these were Valencias shipped from May through October. Increasing supplies of South African and Brazilian oranges are being placed on European markets during these months and there are indications of greater competition from these sources in the future. Growers of winter oranges can expect an outlet in Europe for only a relatively small quantity of the higher-grade fruit in view of the keen competition from Spain and Palestine.

Florida, with a total grapefruit acreage, estimated at 80,000 acres, has approximately 95 per cent. of bearing age. Texas with approximately 70 per cent. of the acreage of Florida, is estimated to have only about 20 per cent. of bearing age. The California bearing acreage is reported as 9,000 with a forecast of 11,800 bearing acres for 1932. Porto Rico with an acreage estimated at 3,800, has not fully recovered from the damage resulting from the hurricane of 1928. It is reported that not until another season will Porto Rico be shipping as heavily as before the hurricane.

There are good prospects for a continued expansion in the foreign markets for grapefruit. In 1929 Great Britain took more grapefruit than ever before, but the *per capita* consumption is still far behind that of the United States or even Canada. Porto Rico is supplying an increasing share of the British grapefruit imports. Continental European countries are showing a greater interest in grapefruit and the outlet there will undoubtedly expand, particularly if efforts are made to acquaint consumers with the merits of this fruit.

Canning of grapefruit offers another marketing outlet. During the last season 957,000 cases were packed as against 455,100 in 1927. In addition, canners put up 202,000 cases of grapefruit juice.

In view of the prospective large increase in production, especially of grapefruit, during the next few years, and the consequent probable depressing effect on prices, only those with the wisdom and skill in production that come from successful experience or adequate training should contemplate new acreages even for replacements. The outlook with respect to the Mediterranean fruit fly in Florida, is much more encouraging than was anticipated last spring.

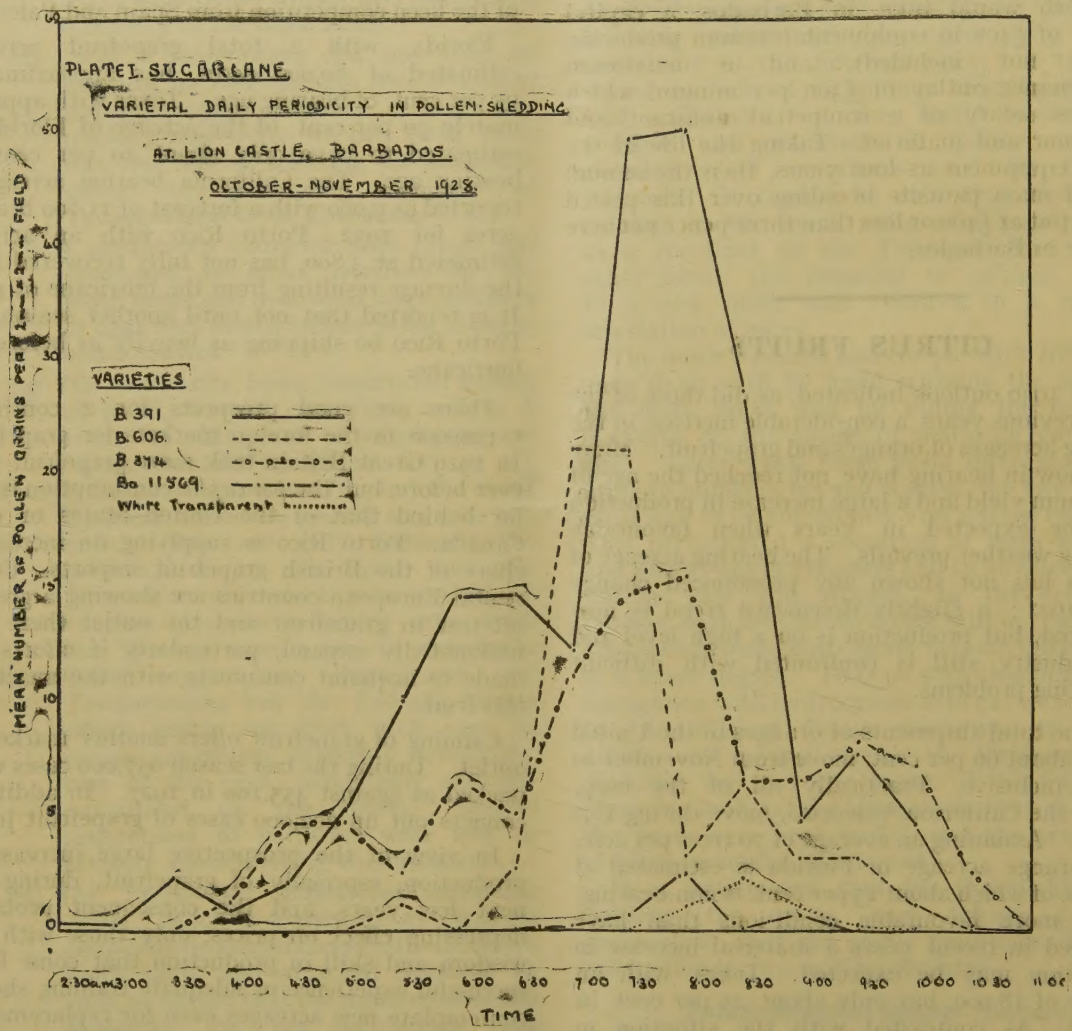
In California, where practically the entire lemon industry of the United States is located, production in some recent years has been so great that difficult marketing conditions have resulted. Bearing acreage has not changed greatly since 1921 although the slightly downward trend which began in 1926 is expected to continue for the next few years. Indications are that production is now near the peak.—(*Mis. Pub.*, No. 73, United States Department of Agriculture.)

POLLEN SHEDDING IN CANE.

Pollen Shedding in Barbados Sugar-Cane Variety.

By A. E. S. McIntosh, B.Sc., Ph .D.,
Geneticist, Department of Agriculture, Barbados, B. W. I.

The daily periodicity in pollen shedding in sugar-cane varieties will always be of importance no matter what system of sugar-cane breeding is employed. Hybridisation will be the method of producing suitable varieties whether the breeding system continues to be the present method of crossing heterozygous plants and eliminating the chance element by other means, or by synthesising varieties from pure line material. If the latter method is ultimately used, it is very unlikely that a good commercial type will eventuate during the process of selfing to obtain pure lines. Assuming then that hybridisation will always be an essential, the necessity of knowing the nature, amount and time of shedding pollen by parental plants is obvious. Female fertility will not be considered in this paper. In all cases, the commercial sugar-cane varieties in Barbados have a heterozygous constitution and so far no sustained attempt has been made to obtain pure lines.



From observations made on and data collected from seedling populations of selected parentages, it has been possible to gain information on hereditary tendencies in such parents and accordingly it is known what particular features of commercial value are handed down by varieties with a considerable degree of frequency. An intelligent selection of parents can be carried out and groupings made for effective hybridisation work. Before such groupings can be made, however, there remains the necessity of finding out the flowering phenomena in such chosen parental varieties. The extent and time of arrowing and female fertility are phenomena which must be closely studied for each, as well as the extent and time of pollen shedding and the fertility of such pollen.

This paper is concerned with the extent and time of pollen shedding in Barbados varieties, and some points which arise out of the data presented and which may be of interest, are brought up at the conclusion of the article.

In Barbados, arrowing takes place during October, November and December towards the end of the rainy season. During the arrowing seasons of 1928 and 1929 data was collected for the varieties, B 606, B391, B.H. 10 (12), B374,

Ba 11569, White Transparent, B 755, B 663, B 891 and B 831. All work was done on plants growing in the field under ordinary plantation conditions.

The method of obtaining counts was as follows: For any variety two normal arrows were selected when flower opening and pollen shedding were in full swing. This was generally about 12 days after the protrusion of the tassel from the last leaf sheath. Any arrow was employed only so long as it was opening new flowers. So soon as this fell off, the arrow was discarded and a fresh one selected. The cane bearing the arrow was bent over so that the latter was sheltered from winds or light breezes by the surrounding cane foliage. It was necessary to do this so as to avoid excessive pollen loss due to shaking in the intervals between counts. And indeed this is obviously a method fitted to give a truer representation of the actual periodicity in shedding.

Each arrow was held over a glass plate held immediately below the region of anther protrusion and dehiscence. These plates were thinly smeared with glycerine so that falling grains should adhere and each was divided into numerous two mm. by two mm. squares. The arrow was very gently tapped over the plate and the pollen fall was recorded by noting (under a compound or dissecting microscope) the number of grains for each of 50 fields and computing the mean of this number. For the variety two arrows were always taken and the average number of grains per field (two mm. by two mm.) obtained for the variety for any one time by summing the mean for each of 50 fields and dividing by two. Such records were made every half hour during the shedding period.

Preliminary observations indicated that no shedding—or at most a negligible amount—took place between 10 a.m. onward until 2 a.m. on the following morning. This daily period was therefore dismissed and attention was focussed on the period between 2 a.m. and 10 a.m.

The data is presented in graphic form. The breeding seasons 1928 and 1929 are treated separately. For 1928 eighteen half-hourly periods are presented. These embrace a period between 2 a.m. and 11 a.m. It is seen from the graph that little or no shedding took place before 4 a.m. and after 10 a.m. so that the periods before the former time and after the latter were omitted in the 1929 observations.

The figures obtained for any point at any half-hour are an indication of the average extent of dehiscence and shedding which takes place in any two arrows in the period between the time indicated by that point and the previous one.

Speaking generally of pollen shedding in all varieties it is seen that it is mainly confined to comparatively short periods which indicate shedding between 6 a.m. and 8.30 a.m. Prior to 6 a.m. most of the varieties display very low shedding and after 8.30 a.m. the amount of pollen falling on to the plates dwindles almost to zero (as seen in the 1928 graph) after 10 a.m.

Two important points are apparent in the graphs. These are the varietal differences in pollen shedding in (*a*) time and (*b*) amount.

In the 1928 graph the greatest sheds are for the period between 7.30 a.m. and 8 a.m. This is also the case for 1929. In both years, however, some varieties depart from this general optimum period. In both it is seen that B 606 reaches its maximum between 7 a.m. and 7.30 a.m. the period prior to the above. B.H. 10 (12) is earlier still (c.f. 1929 graph) and has a very decided optimum in the 6 a.m. and 6.30 a.m. periods.

Again there are varietal differences in the duration of pollen shedding. B 391, B 374 (1928), B 663 and B.H. 10 (12) (1929), shed appreciably over long periods while B 606 sheds in considerable amount over a comparatively short lapse of time. Ba 11569, White Transparent (1928) shed feebly and that in a short time, as is also the case with B 831, B 891 and B 755 (1929).

The varieties show great differences in shedding amount. B 391, B 374, B.H. 10 (12), B 663, B 606 all shed heavily, B 663 and B 391 especially so. B 891, B 831 and B 755 are intermediate in this respect while Ba 11569 and White Transparent shed feebly. In the two last varieties the few grains shed are for the most part poorly developed and do not suggest an ability to germinate or fertilise.

Reverting to the distribution of shedding in time B 606 presents points of interest. This variety sheds comparatively heavily but for a short time only. There was practically no dehiscence until about 6 a.m. At this time the anthers commenced to split and shed pollen in great amount. This shedding was over by about 8 a.m.

This heavy shedding over a short period was observed for five shedding days in 1928 and 20 in 1929. It recurred morning after morning.

There are two points, however, worthy of note in the pollen shedding in this variety. In 1929 observations were made and data obtained for 20 days during the arrowing season. The extent in time of pollen shedding was considered for two consecutive divisions of the 20 days, *i.e.*, divisions of ten days. Means were obtained for the periods from the sums of the ten day observations.

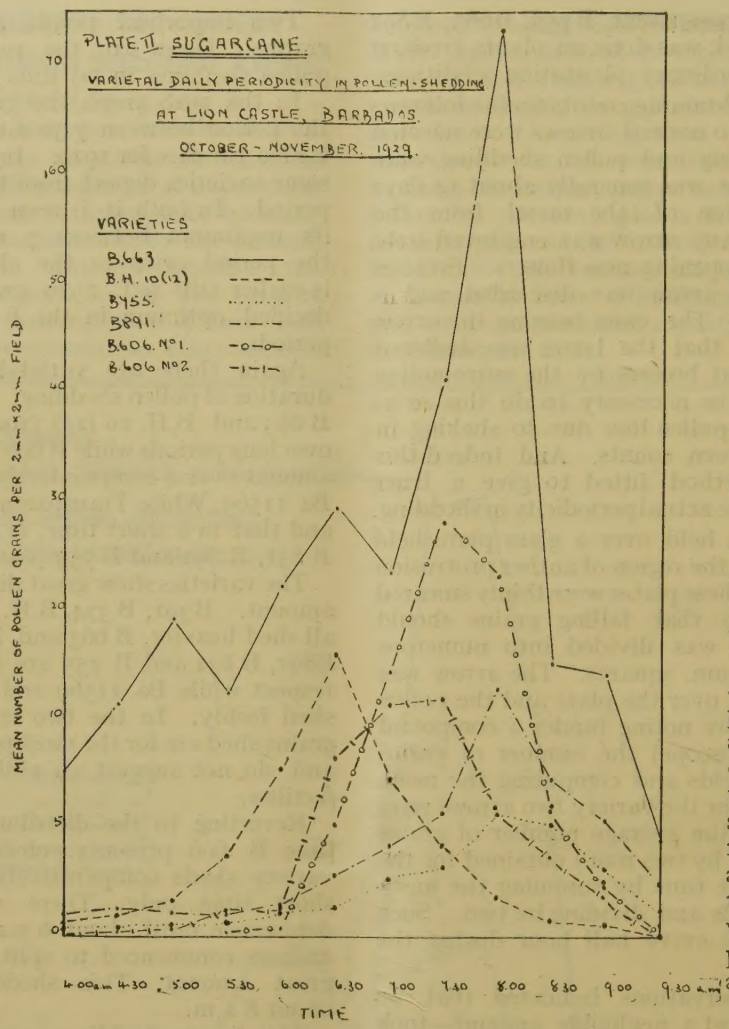
It can be seen (Plate II, B 606 Nos. 1 and 2) that the duration of shedding varies. The first division (*i.e.*, the earliest recordings for this variety in the 1929 breeding season) reveals sheds between 6.30 a.m. and 8.30 a.m. while the other commences about 5.30 a.m. and continues until 8.30 a.m. Moreover, there is a shifting forward of the point of optimum shedding in the second period. Again the actual amount of pollen shed diminishes as time goes on.

The latter is probably a growth phenomenon and may quite possibly be common to all varieties and may be considered the resultant of many internal and external growth promoting and influencing factors.

The former point, however, viz.: the shifting forward of the point of optimum shedding in the variety as the arrowing season progresses may be due to a slight change in the daily evaporation periodicity.

During the collecting of the above recorded data meteorological records were continuously made. Atmospheric temperatures and humidities were made on a continuous recording thermograph and hygrograph (unscreened) in the vicinity of the selected arrows. Sunshine records were also made on a sunshine recorder.

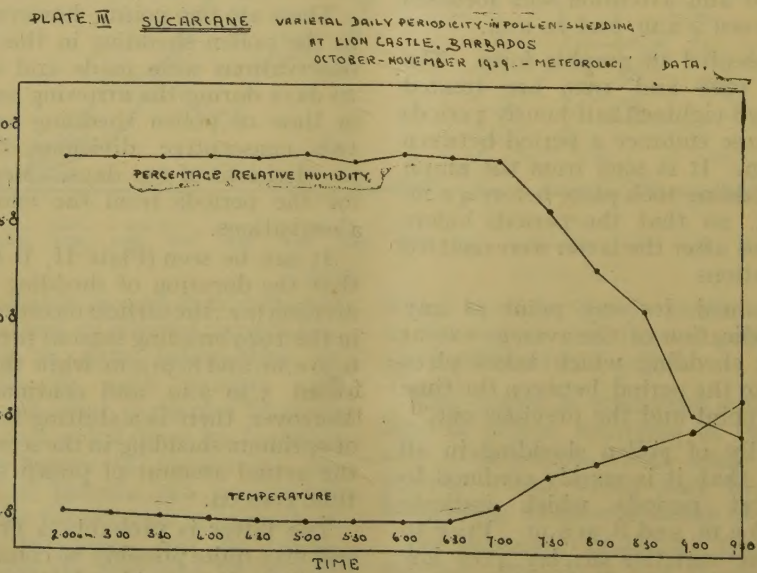
The mean daily atmospheric temperatures and percentage relative saturations are given on Plate III for half hourly periods from 2 a.m. to 9.30 a.m. for 16 days during the arrowing season.



It is seen that both are practically constant from 2 a.m. to 7 a.m. After this the temperature rises while the percentage relative saturation drops until 9.30 a.m. There was no appreciable divergence from this throughout the 16 days period.

Personal observations were made on the air movements throughout the period in question. From these it was seen that as the period advanced the air movements were earlier. As a rule the atmosphere was still during the night, especially so around 5.00 a.m. to 6.00 a.m. at which time temperature was lowest and percentage relative saturation highest. At the end of this time a faint breeze started and increased in intensity to give an appreciable breeze which remained fairly constant throughout the day.

From these observations it was made apparent that dehiscence was probably more a resultant of evaporation than of actual humidities and temperatures. Evaporation is known to be greatly affected by air movement. The earlier daily point of optimum shedding seen in B 606 for observations made later in the arrowing season is probably a resultant of earlier higher evaporation rates at that time than earlier in the season and this was due to an earlier occurrence of marked air movements.



It is hoped to obtain an instrument of the type advocated by Sayre (See *Ecology* IX, No. 2, 1928, page 123) to obtain continuous records of evaporation and to attempt a closer correlation between anther splitting, pollen shedding and atmospheric phenomena.

It is possible that dehiscence itself is brought about by a high internal pressure in the anther cells coupled with a rise in the evaporation rate around the time of commencement of greatest shedding. Shedding prior to 6 a.m. may be due to dehiscence resulting from high internal pressure only and dehiscence after this is accentuated by an increasing evaporation rate.

The following points of practical importance arise from the above observations :

(1) A knowledge of daily periodicity in pollen shedding admits of collecting male arrows at a time when they will, on dusting, be likely to give their fullest pollen shed. This leads to "male" arrow economy and greater hybridising efficiency. In Barbados the procedure is to collect arrows of selected "male" parents around 6.00 a.m. to 6.30 a.m. Each variety has its arrows kept in separate brown paper sheets. These lie in the breeding house until 7.00 a.m. During this time (from 6.00 to 7 a.m.) in the breeding house the anthers are dehiscing but the pollen is not shed—there being no movement. From 7 a.m. to 8.30 a.m. dusting work is carried on.

(2) Observations on daily periodicity in pollen shedding in sugar-cane varieties also reveal the extent of pollen shedding in varieties. This leads to an intelligent selection of male and female varieties for safe hybridisation purposes.

(3) The time of pollen shedding in varieties is also known by such studies. This is useful, for it admits the safe use of several male varieties as female. Thus, B 606, although shedding pollen heavily does not commence to do so for approximately two hours after such varieties as B 391, B 663 and B 374 have commenced to shed. Thus during this period it may be used as a female plant in crossing work and so the range of genotypic expression in the seedlings will be extended by the addition of more varietal combinations.

COCOA PLANTERS' ASSOCIATION.

Report for 1929-1930.

THE Report of the "Cocoa Planters' Association of Trinidad, Ltd.", for the year ended 30th June, again shows evidence of sound and satisfactory growth. Cacao sold realised a gross average of $10.90 a fanega (110 lb.), the lowest price since 1923-24, but, under the circumstances, higher than had been anticipated. Following the practice of previous years the sum of 12 cents a fanega was set aside for working expenses, but out of this a sum of $3,162.56 was credited to individual members, according to the quantity of cacao produced, and added to the Deferred Deposit Fund which now stands at $49,744.74.

The membership continues to increase at a steady rate. At 30th June, 1929, the registered membership was 217 estates producing approximately 63,704 bags (of 165 lb. each) of cacao. Another 27 estates, with crops aggregating 5,150 bags, were added during the year, while eight members supplying 1,460 bags withdrew owing to the sale of their estates. Thus, on 30th June, 1930, the registered membership consisted of 236 estates with an average production of 67,394 bags of cacao. Since that date another seven estates, with nearly 1,000 bags of cacao, have been added. The Association now markets nearly one-fifth of the island crop.

In presenting the report the Chairman, the Hon. Carl de Verteuil, C.M.G., dwelt upon two points of great interest and importance to the local cacao industry. The island crop was very patchy, the Northern Range being below the average, while the centre of the island, another important cacao district, was 20 per cent. below last year's yields. Yet the Sangre Grande—Manzanilla district, which is the most heavily infected Witchbroom area, was 20 per cent. above last year's crop. The Chairman attributed this, in large measure, to the increased attention paid to cultivation necessitated by this disease. Thanks to the co-operation of the planters and the Department of Agriculture there is no indication that the Witchbroom disease has as yet seriously affected yields. This year the infection has decreased, but the necessity of intensifying the campaign to control the disease was urged upon the members.

The Chairman next emphasised the desirability of preparing a clean, sound, well fermented, high grade quality of cacao as far removed as possible from the West African product. Trinidad produces at a higher cost than West Africa, but fortunately its cacao is of that choice flavour required by manufacturers to blend with the neutral cacaos of the world. In view of the strenuous and successful efforts which are being made to improve the preparation of cacao in the Gold Coast and Nigeria, he was of the opinion that the very existence of the Trinidad industry depended upon improving the quality of its product. That this policy pays is clearly shown by the fact that a small percentage of superior cacao shipped by the Association realised an average of $13.01 per fanega, compared with only $10.78 for the standard grade.

The present writer urged nearly five years ago (*Tropical Agriculture*, Vol. II, No. 12, pp. 289-291) that such a superior grade should be established. Experience has demonstrated that there exists a satisfactory market for such a quality ; that with the use of grading machines this cacao can be prepared almost as cheaply as the standard grade ; and that the price obtained is considerably higher. Unfortunately those members preparing this superior cacao secure no benefit and receive merely the average price for the standard grade. The writer still hopes that effect will shortly be given to his suggestion that the rules of the Association be amended to enable the proceeds of the superior grade to be divided between those supplying it. When a premium in price is allied with a superior quality there will exist a powerful incentive for the improvement of quality. By this method the Association will extend its policy of improving the reputation of Trinidad cacao.

C. Y. S.

TROPICAL SOIL SURVEYING.

PART III.

III.—The Physiological-Ecological Soil Survey.

(*Continued.*)

By F. Hardy.

In Part II of this article (which was published in the last number of *Tropical Agriculture*), an account was given of the aims of the physiological-ecological soil survey. It was therein indicated that this kind of survey applies to soils of cultivated areas whose relative productiveness with reference to specific crops (timber, orchard crops or field crops) is more or less already known. A useful method of field investigation applicable to such cases is the *soil profile method*, which has been already described. The profile method seems to be especially useful as a first general means of studying the soil environment in detail, particularly where the land has not been disturbed by deep tillage, as for example, in forest areas and in orchard fields. One important attribute of soil profile study is the information it supplies as to the thickness and depth of the various soil horizons that are characterized by easily-recognisable differences in composition and properties. The knowledge of these facts enables the soil surveyor to select and decide appropriate sampling depths when a survey is subsequently developed in greater detail. It is evident that the employment of arbitrary and conventional sampling-depths for all sorts of soils, regardless of their stage of natural development, the depth of root-penetration in them, or their alteration by cultivation, is fundamentally unsound. The general adoption in northern countries of an arbitrary surface-soil sampling-depth of 9 or 12 inches (probably based on the depth of the plough-sole or downward limit of soil cultivation for cereal crops), need not necessarily apply to the collection of soil samples in areas growing crops of very different habits. Thus, in our preliminary field examination of the cacao soils of Trinidad and Tobago, we have tentatively recognised, by graphical inspection of data so far obtained, certain quite definite horizons which contribute differently to the nutrition of the cacao crop. The thickness and depth of these specific horizons seemingly depends, not only on the rooting habits of the cacao tree, but also to some extent on the physical texture of the soil (as decided mainly by the nature of the parent soil material), and on the extent to which various soil-changing factors have operated since the land was first utilised for cacao production.

Decisions having been reached as to the proper depth or depths of sampling through soil profile studies, the next step in the detailed soil-survey involves the collection of a relatively large number of soil specimens at numerous sites within an area where any particular sort of soil is represented. The rapid field and laboratory examination of this material eventually yields evidence of *lateral* variation of the soil, in contrast to vertical variation, such as is detected by profile study. It therefore furnishes data for the construction of soil maps.

In cultivated areas where crop-yield data are available, the detailed soil survey can be extended so as to include the collection of additional data having direct bearing on soil fertility. The knowledge so gained may be of considerable value to the plant-grower in that it may provide information regading soil deficiencies. Thus, the recent detailed soil survey by O. Arrhenius of the cane-lands of Java has proved useful to Javan sugar-planters, because its results immediately indicated the particular soil factors that limit the growth of sugar-cane in their canefields. It especially revealed the importance of soil reaction and of soil-phosphate in cane production. Our own similar but independent survey of the cane-lands of Trinidad, commenced in 1926 (about the same time that Arrhenius' survey was being conducted), and since rapidly extended, may prove of similar benefit when its full significance has been realised and properly stressed. Previous detailed soil surveying in Hawaii, and more recently, a preliminary survey of Cuba, likewise are yielding results of considerable practical value.

The Determination of Dynamic Soil Factors in the Physiological-Ecological Soil Survey.

So far our discussion of tropical soil surveying has concerned the determination of certain fundamental soil-factors that are *not* liable to marked periodic fluctuations during a single growing season, namely, soil texture, soil reaction, organic matter and nitrogen contents, carbon/nitrogen ratio, and (to lesser extent), rate of solution of potential plant nutrients. These do not embrace *all* the static factors that control plant-growth, but they include those that are really important and that are susceptible of easy measurement. A fuller presentation of the subject has already elsewhere been attempted by the writer[1] in an article which describes the manner in which closely-spaced, "spot" soil-samples may be grouped on a texture/reaction basis for the purpose of lessening the number of laboratory determinations. It also describes the construction of detailed soil maps based on the experimental data.

It now remains to consider briefly the dynamic aspect of soil examination, whereby fluctuating growth factors are periodically assessed, so that differences in fertility between circumscribed areas or plots might be accurately characterized. The chief dynamic factors controlling plant-growth appear to be (1) *water-supply*, (2) *supply of nutrients* (especially nitrate, phosphate, lime and potash), (3) *air or oxygen supply*, (4) *soil temperature*, and (5) *micro-organic activity*. Most of these factors are mutually interdependent.

Certain of them depend, moreover, on *soil-tilth* (*i.e.*, granulation, which is decided, not only by mechanical composition, but more especially by the arrangement of soil particles into aggregates and flocules). Tilth is generally expressed in degree of compaction, and, as such, may be periodically, though only roughly, measured by means of a soil-compaction instrument whose action depends on the number of strokes of a plunger-hammer which drives a steel torpedo-shaped body a certain distance into the soil. *Water supply* to plants is conveniently measured in the field by use of an "artificial root," which usually consists of a conical body, such as a porous porcelain cone (the Livingston "soil-point"), whose surface exposes a water-absorbing medium of convenient area to a moist soil into which the instrument is pressed. By weighing the instrument (or better, a group of them) before and after contact for a definite period of time, the water-supplying ability of a soil may readily be determined at any instant [2], [3]. Simultaneously, soil samples may be collected for determination of gross moisture contents and for determination of *readily-available nutrients* whose concentration is liable to periodic fluctuation. The measurement of readily-available nutrients by an electrical conductivity method, first suggested by Atkins, has already been briefly noted in Part II of this article. Its applicability to soil fertility studies has been fully explained by Mr. C. H. Wright of the Nigerian Department of Agriculture, in a paper which appeared in the September number of this Journal [4]. Mr. Wright found that Atkins' method furnished an extremely useful index of fertility in cotton and maize-plot soils, provided the soil samples for comparison were taken at identical and regular times throughout a growing period. Furthermore, Mr. Wright proved that changes in electrical conductivity of his soil extracts were accompanied by corresponding changes in soluble nitrogen and calcium. Low values were obtained in the wet season because of removal of substances in solution by leaching due to rain-water and by nutrient uptake by the growing plants, and high values in the dry season because of increased soil micro-organic activity.

Air or oxygen supply in the soil is difficult to measure, and, so far as the writer is aware, no rapid method has been evolved. A pyrogallol absorption method has been elaborated by Dr. Livingston and Dr. Hutchins in the United States of America [5], but it does not appear to be sufficiently simple nor reliable for use in the field. Closely connected with oxygen supply is the state of a soil as regards its ability to oxidize or to reduce unstable compounds, such as occur in plant residues and in mineral soil products. The conception of oxidation-reduction potential of a soil, as expressed on a scale (rH scale, comparable with the pH scale on which acidity-alkalinity is now-a-days expressed), offers a wide but difficult sphere of investigation to the soil chemist. Doubtless the state of a soil with reference to its oxidation-reduction potential is a most important factor for consideration in fertility studies. Unfortunately, no satisfactory technique for measuring it has yet been devised. Promising results have been obtained by electrode methods for measuring oxidation-reduction potentials in certain biological and chemical systems in which the processes are reversible, but the difficulties appear to be enormously greater in irreversible systems, such as are presented by plant residues comprising soil organic matter decaying under different conditions of aeration or waterlogging.

Soil temperature, as a physiological-ecological factor controlling plant growth, is liable to fluctuation according to topographical aspect, presence or absence of vegetative cover, colour of surface soil, depth of soil, soil texture, moisture content and rate of evaporation. It shows a marked lag in comparison with corresponding air temperature, but is not so prone to variation. Its direct effect on plant growth is hard to estimate, since so many other factors are affected by temperature changes. There is usually not much difficulty in obtaining soil temperature rendings; the trouble lies mainly in their interpretation.

Micro-organic activity may be assessed by its effects on the nutrient status of a soil (*e.g.*, fluctuations in ammonium, nitrite and nitrate-ion). There is usually no need for the chemist to ascertain the exact composition of the soil flora and fauna, excepting when it becomes necessary to explain certain peculiar or abnormal changes in nutrient-ion concentration.

The work involved in collecting records of the dynamic or fluctuating factors controlling plant-growth, may become very laborious, unless adequate staff and laboratory facilities are available. Nevertheless, the results furnish reliable indications of soil deficiencies, both manurial and cultural, and as such, fully justify the trouble taken to collect them. They certainly enable the soil investigator to co-operate more closely with the farmer or planter in his efforts to increase the productivity of his lands through the accurate identification of the particular growth factors that require amelioration.

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(4) *Electrical Conductivities of Soil Extracts.* C. H. Wright, *Trop. Agric.*, Vol. VII, 1930, p. 247.

(5) *Oxygen-supplying Power of the Soil as indicated by Colour-changes in Alkaline Pyrogallol Solution.* E. M. Hutchins and B. E. Livingston, *Jr. Agric. Res.*, Vol. XXV, 1923, p. 133.

COTTON NOTES.

An article by McKay and Goodspeed entitled "The effects of X radiation on Cotton" appears in *Science*, No. 1851, of 20th June, 1930, describing a series of experiments which suggest that hereditary alterations both of a qualitative and quantitative nature may be produced in cotton by treating the pollen with high frequency radiation.

During the summer of 1927, when Muller was carrying out his classic experiments on the effect of X-rays on Drosophila, similar experiments were carried out with a population of cotton plants grown in the green houses of the University of Texas. Flowers of a strain known as "Half and Half"—a highly selected commercial strain, were emasculated in the evening before opening, and the anthers placed in gelatine capsules.

Next morning the pollen, which by that time had shed, was treated with X-rays in varying dosage. The X-ray exposures used were 4, 8, 12, 16 and 25 minutes with a set-up of 50 kv., 5 ma., target distance of 10 cm. and an aluminium filter. Seventeen mature fruits were obtained from X-rayed pollen × untreated eggs, and these contained 311 seeds. From 150 seeds sown in California only 21 plants were obtained. In the fruits obtained from treated pollen there was a great reduction in the number of seeds per fruit, showing that sterility is a by-product of the treatment.

The 21 plants were compared with control plants grown from untreated pollen, and it was apparent that many changes of character expression had occurred. Among the more striking of these was the presence of twisted and deformed stigmas, anastomosing leaf veins, peculiarities in leaf shape, fasciated and enlarged stems, incomplete flowers, and dwarfness in habit. Considerable sterility was also manifest in the offspring of treated pollen. Only 12 of the 21 plants produced fertile fruits during the 1929 growing season, and the seeds from two of these were empty. In the ten fertile plants there were three which produced much larger seeds than the controls, and two plants gave seeds from which the lint was entirely free at maturity, resulting in what might be termed naked seeds.

The experiments are being continued, and cytogenetic analysis of the X_1 and X_2 generations.

It is difficult to make out exactly what the authors mean by their "naked seed" type. The naked seed in Upland has been much worked on genetically, and has been established to be dominant over the ordinary fuzzy seed. If the X-ray treatment has induced a dominant mutation a fact of extreme interest has been established.

Preliminary experiments on the treatment of pollen with X-rays have been commenced at the Cotton Research Station. The pollen was that of Sea Island Superfine and the female parent was a chlorophyll deficient with six genes in a recessive condition. If treatment has induced mutation in any of the six genes the F_1 generation will show the effect. The results should be of great interest.

A paper by Mohammed Afzal on inheritance in cotton appears in the *Memoirs* of the Department of Agriculture in India, *Bot. Ser.*, Vol. XVII, No. 4, Feb., 1930. This paper describes the results of work carried out at the Imperial College of Tropical Agriculture on a cross between *G. cernuum* and *G. indicum* (Burma Silky). The only character inherited in a simple manner was the degree of laciniation of the leaf, though it was shewn that minor genes affected the expression of leaf shape in presence of the main gene supplied by the *cernuum* parent.

The mode of inheritance of the other characters was not elucidated. The author found that length of lint was inherited independently of lint index and seed index, so that it should be possible to combine long lint with high lint index. It may be noted, however, that no plants with very high lint index were selected for cultivation in F_3, the highest value being 53. It would have been interesting to have worked out the correlation coefficient for lint length and lint index in the separate families of F_3. The range of lint length covered by F_3 families is not very great, the means ranging only from 20.9 to 25.2 mm.

Kearney (Cotton Plants, Tame and Wild, *Journal of Heredity*, Vol. XXI, May, 1930), discusses the biological significance of the seed hairs of cotton. It has been pointed out previously (Balls) that a lock of seed cotton is peculiarly ill adapted for dispersal by wind, and Kearney emphasises the fact that the seeds of some wild species, *e.g.*, *G. Sturtii* and *G. Davidsonii* are practically devoid of lint which therefore cannot be of any value as a means of disseminating the seeds. Birds very often use seed cotton for building their nests, and A. K. Fisher collected seeds of a wild cotton from the nest of a finch. It has been thought by some botanists that the seed hairs may serve the plant by absorbing moisture and retaining it close to the seed, thus facilitating germination. The xerophytic types of wild cotton, however, without exception, are almost devoid of hairs, and do not seem to be mal-adjusted to their environment. It is probable that the lint hairs serve no particular function at all in the economy of the plant, and constitute one of a large number of apparently neutral characters. The presence of a large amount of lint will, however, intensify natural selection, for out of a single lock involving five to nine seeds, only one seedling usually comes to maturity. Any mutation in the direction of weakness will tend to be eliminated from the start. It would be interesting to compare the F_2 of an interspecific hybrid, (*a*) grown from single seeds (*b*) grown from whole locks.

S. C. Harland.

PHYSIOLOGICAL ASPECTS OF PLANT NUTRITION.

[*Note.—The following abstract is taken from an article by Dr. E. M. Crowther, Head of the Chemistry Division of the Rothamsted Experimental Station, published in the* Annual Report on the Progress of Applied Chemistry, 1929, p. 532. *It stresses the importance of studies of the effects of soil nutrients—both those normally present and those added in manures—on the fundamental processes that go on within the plant-body, and which affect ultimate yield and quality.* EDITOR.]

THE full understanding of the relation of soil conditions to the growth of plants requires, not only a knowledge of the factors influencing the availability of nutrients in the soil and their absorption by the plant, but also of the effects of the various manurial constituents on the fundamental processes within the plant. In extreme cases, nutrient deficiencies can be recognised by the appearance of the plant itself. Through careful compilation of lists of visible symptoms that appear in plants modified by non-parasitic affections (such as may be caused by deficiencies of nitrogen, potassium, phosphorus, calcium, and magnesium, &c.), it may eventually be possible to prepare schemes for diagnosis. These may perhaps serve as supplements, or even as substitutes, for the estimation of nutrient-availability by chemical soil analysis, pot culture or seedling analysis. Surprisingly little is known about the effects of the principle nutrients on the chief physiological processes that occur within the plant.

At Rothamsted, F. G. Gregory and F. J. Richards have recently shown that nitrogen starvation reduces the rates of respiration and of assimilation in barley plants grown in sand culture. Phosphate starvation was found to have no effect on respiration, but to cause an increase in the assimilation rate. Potash deficiency, however, shows the most marked effects. It greatly increases the rate of respiration in barley, but reduces the assimilation rate. Potassium has often been associated in a loose way with the condensation and transport of the products of carbon assimilation, but it is now suggested that the principal action of the potassium supply in limiting assimilation is that it determines the bicarbonate content of the leaf, and thus the rate at which carbon-dioxide can diffuse through the cells to the chloroplast surface. In an investigation on the influence of potassium salts on the composition of the potato plant, A. Dhein in Germany found marked effects, not only on the water and chlorophyll contents of the leaves, but on the ratio of acids to bases in their ash.

In the comparison of *ammonium salts* and *nitrates* as plant nutrients, attention is generally given to the permanent effect on the soil reaction of the nitrification of the ammonium salts or to the so-called physiological acidity or alkalinity that may arise from the greater absorption of the ammonium or nitrate ion respectively. In Russia, D. N. Prianischnikow has shown that when both of these factors are eliminated, there still remains an important difference between the effects of the two ions. Sugar-beet and maize grown in sand cultures, with frequent renewal of the culture solutions so as to maintain approximately constant reactions, gave much better results with ammonium than with nitrate at pH 7.0, but much poorer results at pH 5.0. In the acid solution, the plants receiving ammonium had a much lower calcium content than those receiving nitrate, and the yield was greatly increased by increasing the calcium, potassium, and magnesium contents of the solution. In neutral solution, increasing the metallic ion concentration had little effect on the plants grown with ammonium ; decreasing it greatly reduced the yield of plants grown with ammonium, but increased the yield of those with nitrate. The relative effects of nitrate and ammonium may thus be altered at will by changing the concentration of either the hydrogen ion or the other cations. With either form of nitrogen an "ammonium poisoning" is caused when the synthesis of carborhydrates in the plant is restricted for any reason, such as excessive acidity of the nutrient solution or the presence of anaesthetics.

O. Owen has given full analytical data for the nutrient content of tomato plants grown with varied manuring at the Cheshunt Research Station in England. The greatest difference between the manured and unmanured plants or fruits is shown in the *potash* content ; the nitrogen and phosphoric acid may increase up to two-fold, but the potash content may increase up to six-fold on manuring. Phosphatic manuring was found to be less important than was suggested by American work. It may be noted that L. Meyer, in Germany, found that the young tomato plant exhibited evidence of phosphate shortage within eight to ten days so clearly that it can be used as a sensitive and rapid indicator of phosphate deficiency in soils.

Comparison of the analyses of oat plants with the development of adventitious roots indicate that the number of roots present controls the quantity of mineral nutrients absorbed by the plants. It has been shown both by W. E. Brenchley, at Rothamsted, and by O. Tueva, in Russia, that the barley plant can take up enough phosphorus from culture solution in five to six weeks to enable the plant to make its maximum dry weight. In the Russian experiments, subsequent supplies of phosphorus were assimilated, but interfered with grain production. M. von Wrangell studied the rate of absorption of the ions of ammonium phosphate by maize seedlings. The ammonium was absorbed extremely rapidly and phosphate relatively slowly.

As regards the special benefits of *potash manuring*, it has repeatedly been demonstrated that the value of potash applications lies in their effect on crop quality rather than on yield. Several instances of such improvements may be noted. A. Jacob gives the results of numerous field trials showing higher volume-weight of cereal grains from potash manuring. It is well known that potash manuring can increase the

resistance of wheat to yellow rust. In observations on the experimental plots at Bonn, in Germany, F. von Meer found that the severity of the attack decreased as the amounts of chloride in the potash fertiliser increased. The extra chloride in the fertiliser caused a fairly regular increase in the acidity and chloride content of plants collected after the blooming period. F. Tobler investigated the effect of potash fertilisers on the structure of fibre cell-walls in fibre plants. With flax, potassium sulphate gave a higher yield, more compact and more angular bundles, and thicker-walled cells than did potash manure salts. For flax, hemp, and ramie, potash fertilisers induced the formation of smoother fibres with a consequent decrease in the loss in separating and with improving spinning qualities.

In recent times, considerable attention has been given to the role which certain *less-common elements* play in plant nutrition. Thus, a few years ago citrus and walnut trees growing under irrigation near several citrus-fruit packing-houses in Southern California, developed pathological symptoms such as a yellowing and dying of the leaves, similar to those known for many years but not understood in other abnormal areas. The trouble has now been traced to toxicity due to *boron* present in a water-soluble form in amounts of a few parts per million of soil. Normal leaves contained less than 100 parts of boron per million of dry matter and the injured leaves contained from 360 to 1100 p.p.m. Near the packing-houses, the boron was traced to contamination of the irrigation supplies by the discharge of waste fungicides, and in the other cases to the gradual accumulation of boron brought down from the mountains in the rivers providing the irrigation water.

The very striking crop responses obtained in the Florida Everglades to applications of 50 lb. per acre of *copper sulphate* raised the question whether they were due to a direct nutritional effect or to some indirect fungicidal or precipitating action in the soil. It has now been shown that it is immaterial whether the plants receive the added copper or manganese sulphate through the soil or by direct application to the leaves. The crop failures in these calcareous soils therefore appear to be due to chlorosis caused by an actual deficiency of these metals.

The special case of *iodine* in plant nutrition merits attention. The argument has been advanced in Germany that the reduced crop yields after the war were to be ascribed in part to the replacement of natural Chilean nitrate which contains iodine by synthetic ammonium salts and nitrates free from it. Although after the agreement between the manufacturers of synthetic and natural nitrogenous fertilisers, this claim may be made less frequently, the "iodine question" has been responsible for much careful comparison of the different sources of nitrogen, and has stimulated enquiries into the distribution of iodine in the raw materials and products of agriculture and its importance in the nutrition of plants and animals. A large number of field and pot experiments carried out at many centres, however, has failed to support the claim that additions of iodine increase crop yields. It is not even established that the application of iodine in amounts comparable with those available from natural sources will necessarily increase the iodine content of crops. Soils giving plants poor in iodine generally respond poorly to additions of iodine, and in any case the added iodine generally accumulates in the stems and leaves rather than in the seeds, fruits, or tubers. Even in goitre districts, where the prophylactic use of iodine is an established practice, there would seem to be no advantage in endeavouring to increase the iodine content of the crops grown for human consumption as an alternative to supplying iodised table salts, at any rate until there is more evidence that plant iodine has a greater physiological value than other iodine compounds. Studies on the distribution of iodine show that there is no support for the view that the soils of Europe have become impoverished in iodine by long continued cultivation. On the other hand, soils are richer in iodine than their parent rocks and in consequence of their absorptive power must be regarded as a concentrating region for the iodine brought from the sea by air and rain. The amount of iodine removed by crops is generally less than one thousandth of the amount present in the soil and, in addition, is less than that normally provided by the rainfall or by the atmosphere alone, if it be assumed that the plant has at its disposal as much iodine as would be contained in the volume of air required to supply its carbon. Typical values in the iodine balance sheet of a crop are, in grams per hectare : removed in crop 0.3 to 3, present in soil 2,000 to 5,000, added in rain 12, available in the air required for carbon assimilation 5 to 15. It is not yet established that iodine is essential for plants, and although it is known to be a vital element for men and animals, there is no evidence that the direct addition of iodine compounds to the food of farm animals is generally desirable, and over-dosage may cause serious trouble.

The general question of iodine in nutrition is the subject of a report by J. B. Orr and I. Leitch to the Medical Research Council. The whole of the published information up to 1927 is reviewed in a volume which is so valuable and at the same time so cheap and readily accessible that it is not necessary here to do more than direct attention to it.

As regards the particular problem of *grassland deficiencies*, valuable knowledge has been accumulated during the last few years of the great importance of the mineral elements of pasture grass in plant and animal nutrition. Such well-known instances of mineral deficiency diseases as those studied by Thieler in South Africa (phosphorus) and by Aston in New Zealand (iron) are seen to be extreme cases of a phenomenon

occurring in fairly large areas in most countries. Considerable success has already been obtained by supplying the element shown by chemical analyses to be deficient in the herbage, either by directly administering its salts to the animal, or by applying suitable fertilisers to the soil. Thus in cases of "bush sickness" from iron starvation on light volcanic loams and pumice sand in New Zealand, B. C. Aston has obtained good results by applying basic slag to the pastures, or by adding ferric ammonium citrate or spathic iron ore to the ration. In the latter case there was no danger of over-dosing.

There is a much more widespread mineral deficiency, which reduces the feeding value of the herbage without being acute enough to lead to definite pathological symptoms in the animal With this mineral deficiency there is generally associated a protein deficiency and an absence of leafiness and succulence in the herbage. The grazing animals select the plants richer in minerals, and the other coarser fibrous plants accumulate. Their residues decompose slowly, and a surface mat of undecayed vegetation begins to cover the surface of the soil making the conditions still less suitable for producing useful herbage. In the course of time, the surface mat grows in humid countries to a bog or peat. This has been the history of large areas of the Highlands of Scotland, especially since the produce of the animals, formerly consumed on the land and returned to the soil, has been exported as meat and milk to industrial districts. Similar results are to be expected in the great meat-exporting countries unless attention is paid to the possibility of conserving the mineral supplies of the pastures. It is demonstrated on the other hand, that by careful study of the composition of the herbage and by improvements through the use of fertilisers and better cultural methods, a great improvement is possible in the productivity of the world's pastures.

The value of close grazing and nitrogenous manuring in producing a herbage of high feeding quality is fully confirmed in numerous investigations in many countries on the composition of grass and the methods of pasture management. The drought of 1929 in Great Britain demonstrated the difficulty of applying a system of intensive rotational grazing in its entirety in countries liable to summer drought, and the principal result of the practical trials and propaganda has been to increase the use of early spring and late autumn dressing of nitrogen on ordinary pastures, with the object of extending the grazing season at both ends. The way in which animals continued to thrive during 1929 on dried-up pastures carrying very little herbage may be regarded as an additional demonstration of the merits of close grazing.

An entirely different group of grassland problems is encountered in the maintenance and improvement of golf greens, lawns, and sports fields. As a beginning, a thorough investigation is to be made of the theory that the finer grasses are favoured by an acid reaction and frequent additions of ammonium salts.

SOIL ANALYSIS.

Its Meaning and Significance to the Practical Agriculturist.

[*Note.—Many practical agriculturists still believe that a chemist, merely by analysing a single soil-sample in the laboratory, is able to prescribe suitable fertilizer treatments for the soil. That this view is no longer held by agricultural chemists is a matter worthy of note by the plant grower. The following abstract of a review of the subject by Mr. H. J. Page, formerly Chief Chemist at the Rothamsted Experimental Station, and now Head of the Research Division of Messrs. Nitram, Ltd., is therefore of interest. The review appeared in the* Annual Report of the Society of Chemical Industry *on the Progress of Applied Chemistry*, 1930, p. 427.—EDITOR.]

Despite the enormous amount of work that has been done on the estimation of "available plant-food" in soils, the soil chemist is unable to state with any degree of certainty, merely on the basis of a chemical examination, the manurial needs of any given soil. He is nevertheless frequently expected to do so, it being a common experience for him to receive a sample of soil from a farmer with the request that he will analyse it and state in what respect it is deficient in plant-food and what fertilisers are needed. In practice, there is usually no difficulty in diagnosing a deficiency of *lime*, with which deficiency probably more cases of crop failure can be associated than with any other. With regard to *nitrogen*, the response to nitrogenous manures on most British agricultural soils is so definite that the benefit of such dressings at their proper places in the rotation is seldom called into question. The position is far otherwise as regards *phosphorus* and *potassium*. Practically any of the known methods will show up a soil in which the supply of either of these elements is at its lowest ebb; the difficult problem arises with soils which appear to contain at least a moderate amount of readily soluble phosphate and potash. Some such soils behave reasonably and respond to phosphatic or potassic manuring more or less as would be expected from their analysis, but soils are not infrequently met with which, on analysis, appear to contain a sufficiency, and on occasion even more than a sufficiency, of one or both of the elements in question, and which nevertheless prove in practice to be extraordinarily responsive to manuring with the fertilisers that would have been deemed unnecessary from the analytical figures. The result is that any agricultural chemist who values his reputation hesitates to give advice regarding the manuring of a soil unless he has available also the results of vegetation experiments, preferably on the field scale, on that or similar soils.

Without doubt, many cases of the failure of soil analysis to forecast the responsiveness of a soil to manuring may be explained by the operation of other limiting factors, the existence of which has been unsuspected or overlooked. *The realisation of the complexity of the soil and of the factors which control crop production, and the increasing degree to which the mode of operation of these factors is*

being elucidated, enable the well-informed agricultural chemist to form an opinion as to the needs of a given soil with greater certainty than formerly. Although it is, in the nature of things, vain to expect that any solvent or method can be found which will give in all cases a clear and direct indication of the manurial needs of the soil, it is desirable to consider the relative merits of the many methods that have been proposed for this purpose.

The oldest and best known method for the estimation of the "available" phosphate and potash in the soil is that of Dyer in which the soil is extracted with 1 per cent. citric acid. This method is the one commonly used in this country. In the United States, preference is given to the use of N/5 hydrochloric or nitric acid. On the Continent, Mitscherlich's method, depending on the use of water saturated with carbon-dioxide, is often used. Studies of different methods have led many continental works to conclude, however, that the Dyer method is generally the most suitable, at least as regards the estimation of "available" phosphate, but for potash, the use of mineral acids appears to be more satisfactory.

As an alternative to the analysis of the soil, that of the plant grown on the soil in question has been suggested as an obvious means of estimating how much of the nutrient material in the soil is available for plant-growth. The difficulty of using full-grown plants for this method consists largely in the need of first ascertaining the composition of an average plant of the sort used in the experiment.

In a recent work by Neubauer and his colleagues in Germany, an attempt is made to get over this difficulty by growing a large number of seedling plants (rye) in a small amount of the soil under investigation, so that the whole of the soil is completely penetrated by the roots. It is concluded that, after the lapse of 18 days, the whole of the readily-available phosphates and potash in the soil will have been absorbed; the plants are then separated from the soil and analysed. This method gave quite promising results, and it merits further trial.

An interesting application of the use of the plant as a means of estimating the manurial needs of the soil is that developed by H. Walker for the soil of sugar plantations. The phosphate and potash in the sugar-cane juices were determined, and it was found that a content of less than 0.02 per cent. and 0.05 per cent. of P_2O_5 and K_2O respectively in the juice was an indication of the need for phosphate or potash manuring.

The ultimate criterion of the need of a given soil for manuring *must always consist of vegetation experiments in pots and in the field*, in which is determined the actual effect on crop-yield of a given fertiliser under conditions excluding the action of non-manurial limiting factors (pot experiments), and under natural conditions (field experiments). A critical experimental comparison of all the more promising of the chemical methods on a series of widely representative soils on which field and pot experiments are also carried out, is much to be desired.

THE AGRICULTURAL VALUE OF MANURES.

[*Note. Increasing attention is nowadays being given by practical agriculturists to the possible economic value of manuring. The following abstract, stressing the need for careful field trials, is taken from the* Annual Report of the Society of Chemical Industry *on the Progress of applied Chemistry, 1927, p. 474. The original article was written by Dr. E. M. Crowther, Head of the Department of Chemistry, Rothamsted Experimental Station.*—EDITOR.]

THE valuation and efficient use of fertilisers depend in large measure on information derived from field trials, but the art of field experimentation has not kept pace with developments in the science and practice of agriculture. It is only during the last few years that there has been any considerable improvement on the methods used throughout last century. Formerly the interest lay in showing that good crops could be grown with artificial fertilisers and in comparing these with farmyard manure. For these purposes, it was sufficient to have a single strip, or quite rarely a series of a few such strips, differing in manuring from the rest of the field. The results of a large number of these experiments extending over many years have now been embodied in general farming practice. The policy of carrying out a large series of simple field trials is still followed for demonstration and propaganda purposes, and is sufficient to show in the course of years whether or not any treatment gives beneficial results under average conditions of soil, climate, and cropping. But such co-ordinated experiments involve a heavy expenditure of time and money, and can be used only for the simplest problems. Isolated experiments of this type are *totally inadequate for the investigation of modern fertiliser problems.* The farmer is concerned, not with the gross increase in yield to be obtained by applying a fertiliser, but with the difference between the selling value of this increment and the extra cost of growing it; in the balance, an advantage or loss of 5 per cent. of the total crop will be a considerable item. There is also an urgent need for more exact information on practical details in the use of fertilisers. Thus, with a nitrogenous top-dressing for cereals, questions arise as to the choice of the fertiliser, the amount of the dressing, and the time of application. In other cases, the balance of the manuring is important. Comparisons are now required between fertilisers which closely resemble one another, and the results must be obtained rapidly before changes in the economic situation have destroyed their practical value. The growing importance of these problems has directed attention to the necessity for considerable improvements in the technique of field experimentation, and some important advances have recently been made.

The prime difficulty arises from the *effects of soil heterogeneity.* Many experimenters, especially plant-breeders, attempted to minimise these effects by increasing the numbers of similarly treated

plots, which were generally set out in regular geometrical patterns. The standard of accuracy was materially increased in many cases, but there was no general recognition of the standard to be attained before an experiment could be regarded as reliable. During the last few years, many important contributions to both the theoretical basis and the practical technique of field experimentation have been made. Special emphasis has been laid on the vital necessity for a valid estimate of the magnitude of the errors affecting the results. This estimate must be derived from the yields of the similarly treated plots. Systematic methods of arrangement by eliminating the elements of chance, destroy the validity of the statistical methods used in estimating the precision of the experiment. By the application of Fisher's "analysis of variance" it has been possible to design lay-outs which reduce the actual errors due to soil irregularity, whilst still retaining sufficient elements of chance to give a valid estimate of the residual errors and the significance of the results obtained. In the "randomised block" method, which is capable of the most general application, the experimental area is divided into a number of compact blocks equal to the number of replications desired, and within each block the treated plots are arranged wholly at random. The components of soil heterogeneity which produce differences in fertility between plots of the same block are completely randomised, while those components which produce differences in fertility between the different blocks are completely eliminated. Where the number of replications equals the number of treatments, the so-called "Latin square" experiment (with a random arrangement, subject to the restriction that each treatment occurs once in each row and each column), allows the elimination of the effects due to differences between the rows and the columns.

The accuracy of the results attained in recent fertiliser trials carried out on these lines at Rothamsted, may be illustrated by comparisons in 4 x 4 Latin squares of the manurial value for potatoes of three sources of potash.

Year.	Average yield.	No Potash.	Pot. Sulphate.	Pot. Chloride.	Pot. Salts.	Standard error.
1925 ..	8.37 tons per acre (=100)	60.1	115.6	112.5	111.8	2.43%
1926 ..	9.45 do. (=100)	87.3	105.0	106.4	101 3	1.91%

In 1925, there was a strong response to all potash applications, the sulphate showing some superiority; in 1926, there was only a moderate response to potash, both sulphate and chloride being superior to potash manure salts.

Experiments of these newer types are inevitably expensive, but it is greatly to be hoped that the importance of accurate information, and the magnitude of the organisations controlling fertilisers will enable increasing numbers of them to be made. The standard of field experimentation should be as rigidly controlled and as openly discussed as that of the laboratory methods of the analyst and research worker.

PLANTATION RUBBER.

Mr. Cyril Baxendale, writing in the British Empire Products number of *The Times Trade and Engineering Supplement* (24th May, 1930), states that while the year 1929 was by no means a prosperous one, to those engaged in the plantation rubber industry, the prospects are far less gloomy than they were in the early months of 1922. In this earlier period the unabsorbed stocks were estimated to exceed 300,000 tons, practically a whole year's absorption. Although the unabsorbed stocks at the present time are not far short of that amount, the rate of absorption has doubled within the past eight years, so that to-day's stocks represent less than six months demand. The areas planted during the boom of 1925 and subsequently, have yet to reach maturity, and it is unlikely that this year's production will show any considerable increase on last year's total of 852,000 tons. Last year's figures were swollen by the policy of all-out tapping following the rest of the six years restriction, and it is unlikely that the yields then attained will ever be secured again. In addition, some 20,000 tons of accumulated stocks were shipped. Absorption has shown an increase of 13 per cent. per annum during the past eight years, compared with an annual increase of 16 per cent. for the eight preceding years. Even if the demand increases at a much smaller rate it is likely that the production will be such as to ensure an improvement in price. All manufacturing countries have increased their demand for rubber. For example, during 1929, the United Kingdom took 71,500 tons, Canada 33,650 tons and Australia 14,975 tons, as compared with 47,818, 30,900 and 8,400 tons respectively, during 1928. One important effect of the restriction period has been the stimulation of scientific research. Promising experiments have been carried out in bud grafting and artificial manuring.

ENTOMOLOGICAL NOTES.

Compiled by the College Department of Entomology.

Insects infesting Stored Cacao.

The Empire Marketing Board, in establishing a Committee on Infestation of Stored Products, has recognised the importance of dealing with the losses, occasioned both in transit and storage, by insect and other damage to a wide range of foodstuffs. By means of a series of grants made to the Imperial College of Science, the Board has enabled that institution to establish at Slough a special laboratory for stored products research. At present, attention is being mainly concentrated on the insect problems affecting cacao and dried fruits, and on fungus damage to cacao and copra. This work is under the general direction of Prof. J. W. Munro, and as experience and facilities increase, it will doubtlessly embrace the study of other products in addition to those mentioned.

A report on insect infestation conditions prevailing in cacao stores, in certain of the London docks and wharves, has been prepared for the Marketing Board's Committee on Stored Products by Messrs. J. W. Munro and W. S. Thompson. This shows that the prevention and control of the losses at present occasioned by cacao insects can only be attained by co-operation on the part of all concerned, since the infestation occurs throughout all stages of the cacao industry.

The problem of insect infestation in stored cacao has three main aspects, namely, (*a*) in the exporting country ; (*b*) in wharves and warehouses of the importing country ; and (*c*) in the cocoa and chocolate factories of the importing country. Cacao insects, for example, may enter the produce in the exporting country and their descendants eventually become transferred to chocolate factories far inland in the importing country. This may result in the occurrence of such insects in boxes of manufactured chocolates which may thus reach the consumer. Furthermore, certain cacao insects may affect other products stored in proximity to cacao and considerably reduce the value of such products.

The chief insects infesting cacao belong to three species. The moth *Ephestia elutella* Hb. is the most important, and its larvae attack not only cacao beans but also a great variety of other stored products, including biscuits, figs, chocolate, many kinds of grain, dried fruits, &c. It is, consequently, an insect of great economic significance, and is very widely distributed. The larvae of another small moth, *Corcyra cephalonica* Staint., are less harmful, since they only occur in small numbers. Like the preceding species, it has become widespread, although it was probably originally a pest of rice and has later taken to living on other products. The third species is the Anthribid beetle *Araecercus fasciculatus* De G., the larvae of which eat out the endosperm of the cacao beans. It is more especially an enemy of nutmegs, and only appears to be a serious cacao pest in the Gold Coast.

The results of Messrs. Munro and Thompson's investigations in London docks and warehouses show that the above species of insects are all found infesting the cacao on arrival from overseas. Cacao received from all exporting countries indicates that infestation takes place in those countries, and if remedial and control measures are to be effective they must be carried out at the sources of the trouble. In Great Britain, it is obvious that whatever measures may be taken to clean up infected buildings, the latter will be liable to become reinfested from fresh cargoes constantly coming in from abroad.

Special attention is being given to the *Ephestia* in order to ascertain the life-cycle and behaviour of the insect under varying warehouse conditions. Its responses to heat, cold, fumigants, and other treatments are being tested, and various experiments have been and are being, conducted relative to the de-infestation of affected buildings where consignments are housed. Under present conditions, clean cargoes stored in the warehouses are open to attack, and it is evident that the problem requires concerted action both by the exporting and importing countries. These facts are fully recognised, and there is little doubt that now investigations have been initiated, we can look forward to a solution of at least some of the outstanding problems.—(*Nature*, Vol. CXXV, No. 3144.)

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Green Scale on Coffee and Citrus.

Serious damage to coffee in Porto Rico, especially during the latter part of the dry season, has recently been caused by *Coccus viridis*, Green (green scale), which also occurs on *Citrus*, guava, &c., in various parts of the island. Coffee plants exposed to the sun and dry weather are particularly infested, as these conditions apparently check the activities of the fungus, *Cephalosporium lecanii*, which sometimes greatly reduces the numbers of the scale. In wet weather, spraying the upper branches with water containing spores of the fungus is recommended. The spray is prepared by scraping off dead scales infested with *C. lecanii* into water, which is then violently shaken in order to dislodge the spores and strained if necessary. In dry weather, when it is useless to attempt to spread the fungus, an oil emulsion spray should be applied. Particular attention should be paid to coffee plants in nurseries, as those attacked may not only be useless for planting but may also spread the infestation.—(*The Review of Applied Entomology*, Vol. XVII, Ser. A, Part 12.)

THE EDITOR requests that any subscriber who fails to receive *Tropical Agriculture* regularly should communicate with him immediately in order that the matter may be rectified.

MYCOLOGICAL NOTES.

The Effect of Damp Storage on Raw Rubber, by B. J. Eaton and R. G. Fullerton.

A full account is given of investigations conducted under laboratory conditions in Malaya to determine the relation between mould development and moisture absorption by rubber kept in damp storage, and the effect of mould development on the loss of weight and on the nitrogen content of the raw rubber. Tests were also made of the comparative fungicidal value of paranitrophenol and trichlor-sodium phenate.

The results showed that smoked sheet and air-dried sheet rubber when allowed to absorb moisture almost invariably develop moulds from spores which contaminate the latex after tapping. The absorption of moisture by raw rubber when stored in an atmosphere of high humidity was found to reach a maximum after a few days. When moulds developed, a loss of weight occurred and continued to increase for a long period; the maximum loss amounted to about 17 per cent. in some 15 months' damp storage. This shows that the hydrocarbon-caoutchouc is attacked, as first grade raw rubber does not contain over five to six per cent. of non-caoutchouc constituents. The losses occurred in a gaseous form, none of the samples being re-washed or treated with any solvent.

When sheet rubber was well smoked moulds developed only after a long period.

The addition to latex of paranitrophenol or the subsequent treatment of the freshly machined sheet with a dilute solution of this chemical considerably retarded but did not inhibit the growth of moulds.

As trichlor-sodium phenate had been stated by the manufacturers to be from five to ten times as efficient a fungicide as paranitrophenol when tested on pure cultures of a number of fungi commonly attacking stored rubber, comparative tests were made on moulds isolated from two samples of smoked sheet. The fungi isolated comprised three species of *Penicillium* (one of which was probably *P. luteum*), four species of *Aspergillus* (probably *A. ochraceus*, *A. terreus*, *A. niger*, and *A. versicolor*), and a black *Torula*. The results showed that while only 0.005 per cent. of trichlor-sodium phenate was necessary to suppress the fungi, 0.02 per cent. of paranitrophenol was required to effect the same result. Further tests demonstrated that the reduced efficiency of trichlor-sodium phenate in estate practice as compared with paranitrophenol is due to the effect of the dilute acid used as a coagulent, which converts this compound into the highly volatile trichlor-phenol.

The development of the chromogenic organisms producing spot disease (caused mainly by bacteria and species of *Aspergillus*, *Penicillium*, and *Fusarium*), in pale crepe rubber causes a loss of weight similar to, but less than, that caused by the moulds which develop in smoked or air-dried sheet.

The growth of moulds causes no loss in the nitrogen content of the rubber, although the nitrogenous constituents may be changed in character by the moulds.

The development of the defect known as "white or virgin" streak was found to be due to allowing the rubber to become damp, and not to the rubber being insufficiently dried during smoking; dry, unsmoked sheet allowed to become damp becomes white and opaque throughout

In the smoke-drying of rubber as carried out during recent years, the wood fuel is too completely combusted, producing a smoke which contains little creosote or other antiseptic constituents, this observation applying only to the effect of the smoking process on mould development and not to its effect on any intrinsic properties of the rubber.—(*Rev. of Applied Mycology*, Vol. IX, Part 5.)

* * *

The Centraalbureau voor Schimmelcultures.

The Centraalbureau voor Schimmelcultures was founded in connection with the Association Internationale des Botanistes in 1905 to 1907. It began as an international body and became fully Dutch on account of the war, which resulted in the dissolution of the Association Internationale. It was then financed for a time solely by Dutch botanists, but later was aided by the Dutch Government. It is now incorporated in the Phytopathologische Laboratorium Willie Commelin Scholten under Professor Westerdijk's direction. The collection included 2,400 species of fungi and about 85 different media were used. The cultures were kept in an unheated room but very low temperatures were not favoured. It was usual to subculture three times a year, but about 800 cultures had to be transferred six times a year lest they should die out. About 100 to 1,200 cultures were distributed each year. A card index of all the cultures was kept and all data concerning them and the diet used was carefully entered. Each transfer was made to two tubes of different media and the next transfer to two tubes of new media. Some attempt was made to record the literature of diagnoses, and of icones on the index card. The work had been hampered during recent years by lack of funds, but a new scheme whereby individuals or institutions could pay a fee of £2 10s. or £5 entitling them to 50 cultures per annum or as many cultures as they required, respectively, free of further cost, is now being put in operation, from which a more settled income will be assured. The co-operation of mycologists has been sought both financially and as regards the sending of cultures to be incorporated in the collection.—(*Colonial Office Report* No. 45.)

The subscription to *Tropical Agriculture* is six shillings per annum, post free, Trinidad currency, to all countries within the British Empire or seven shillings, post free, Trinidad currency, to all other countries. Subscriptions can commence at any time during the year.

TROPICAL WORLD NOTES.

Nigeria.

The output of American cotton from the *Northern Provinces* is slowly but surely recovering from the set-back which it received in 1926. In the Katsina Emirate and Southern Sokoto cotton cultivation is advancing rapidly. In the latter province the output has been more than doubled for each of the last two seasons. The amount of American seed distributed has risen from 2,640 tons last season to 3,173 tons this season. It is distributed free of charge, but it is feared that much is wasted. Weather conditions were good, the rains being copious and well maintained until late in the season.

The crop prospects for the 1929-30 season, were not very favourable at the beginning owing to the exceptionally heavy rainfall during September. The crop, however, made a very rapid recovery, and it is now expected that the yield will be above the average.

In the *Southern Provinces* the outstanding feature has been the greatly increased output of Ishan cotton in the Oyo and Abeokuta Provinces, and the largely increased distribution of Ishan seed, which has actually been sold at ½*d.* per lb. The fact that the seed has been sold may be taken as a guarantee that it will not be wasted, and an increased output of Ishan cotton may confidently be expected. The weather in the south has not been ideal for cotton, since the rains stopped somewhat abruptly in most places.

It is gratifying to record that of the Ishan cotton purchased no less than 75 per cent. was classified as first grade, whereas of the ordinary native cotton of the Southern Provinces 98 per cent. was classified as second grade. The chief reason for this is that the growers of Ishan cotton are those who take cotton-growing seriously and are careful in the harvesting of their crop. — (*Empire Cotton Growing Review*, Vol. VII, No. 2.)

* * *

Brazil.

There has been a continued falling off in the surplus of exports in Brazil. After having been as high as £26,766,000 in 1924, it has decreased year by year until in 1928 it was only £6,757,000, and in the first half of 1929, £1,080,552. Serious doubts are expressed as to the ultimate effect of the coffee defence policy on which so much depends. The concensus of opinion is that the emergence of a record crop largely exceeding the world's requirements in 1927-28 justified, and, in fact, demanded, special action on the part of the authorities and, had the succeeding crops been small, the policy would have worked out smoothly. But, though the next crop was small, it has been followed by another very large one, which cannot fail to increase the stocks to an alarming extent. There can be no doubt that planting has been encouraged by the maintenance of the price.

It is argued that, owing to the defence scheme, the surplus stocks are now held in Brazil instead of in various foreign coffee markets, and that the producers are no longer at the mercy of the foreign dealer as they used to be. This is true, and it is certainly not in Brazil's interest that every crop, however large, should come on to the market all at once. It might have been better if the requirements of the situation could have been met by providing credit and storage facilities for the growers without any artificial restriction of shipments. Such facilities are features of the existing policy, and its ultimate success appears to depend on the gradual relaxation of the control of shipments by the Coffee Institute and its substitution by the extended financing of the producers, to enable them to defend their own interests against speculators, while leaving the laws of supply and demand to rectify the tendency to over-production.—(*The Board of Trade Journal*, Vol. CXXIV, No. 1740.)

* * *

Somaliland.

According to the Somaliland *Colonial Report* No. 1479, a Somali Inspector of Gardens was appointed in July, 1929, whose duties were to ascertain in each district the position of all areas under cultivation, the number of plots, the condition of the areas or plots, *i.e.*, whether marked off with *zaribas** or otherwise, whether at present cultivated, temporarily abandoned owing to the drought, or permanently abandoned, and whether new areas are taken up.

To mitigate to some extent the effect of the drought of 1927-1928, arrangements were made for the issue by the Government, under certain conditions, of Sorghum seed (called locally *jowari*) to those plot-owners who, by some means or other, would be able to cultivate at least part of their holdings. Fortunately, experiments had proved that one Indian variety of the grain—the Sholapuri —was suitable to the conditions, possessed a type of grain of which the natives approved, grew quickly and matured early. A consignment, therefore, of seven and a half tons of this variety was ordered from the Surat Farm in India, and the whole of it was distributed in the course of three weeks. Care was taken that each owner of a plot received in his own hands a quantity sufficient to sow the amount of ground he was capable of cultivating. No seed whatever was handed over to headmen or *akils* for distribution to their section. A note was kept of the name and tribe of each recipient and of the amount of seed issued to him so that a return in cash or kind could be called for from each owner after he had reaped his crop. In some cases, of course, the grain was eaten instead of being sown, but these cases were in a minority. Some sowed it at once, others held it over for a month or two.

A pleasing feature of the distribution of this variety of *jowari* is the fact that there is a demand amongst the natives who have seen it grow for seed of it for the 1930 crop. Experimental plots have been established, where tests have been made with lucerne, varieties of sorghum from India and the Gambia, groundnuts from the Gambia, gram and kulthi from India, Sudan grass, potatoes, and with a number of fruit plants and introduced forest trees.

* A temporary stockade.

Mauritius.

Weather conditions approximated to normal during the harvesting season (July to November, 1929), and factory work was carried on without notable incident.

The total sugar produced was 238,035 metric tons and the total cane crushed 2,195,400 metric tons, giving a mean extraction of sugar of 10.84 per cent. of cane. Owing to the large percentage of Raws turned out in 1929, the recovery of sugar was above normal and the total production thereby increased by about 4,000 tons. The distribution in grades of the sugar produced was as follows:—

Vesous	23.9 per cent.
Raw Sugars	75.2 ,,
Low Sugars	0.9 ,,

In relation to the standing crop, present prospects are, upon the whole, unsatisfactory. Temperature has been below average since December, 1929, and the defect has been accentuated in March of the present year. Unprecedented floods occurred in December previous, some localities registering 75 inches of rain in a few days. The damage to roads, bridges and buildings was, in some cases, heavy but, on the whole, plantations suffered less than would have been anticipated. On the other hand, rainfall was generally short afterwards, the defect reaching 80 per cent. of the normal in March.

From the economic point of view, conditions continue unsatisfactory. The average sale price for sugar in 1929 approximated to Rs. 7.50 per 50 kilos., a figure in many cases below the cost of production.

The organisation of the Research Station is now practically complete. A Senior Geneticist and a Soil Chemist together with Assistants have been appointed and have started work in relation to cane breeding. The services of a Research Botanist have not, however, yet been secured. The scheme is financed partly by the Agricultural College and partly by the Empire Marketing Board.

Considerable progress was made in the tobacco industry. The total acreage under this crop in 1929 was 2,680 and the total crop produced approximated to 450 tons. The greater part of the production was purchased by local cigarette manufacturers. The saving to the Colony is estimated at Rs. 1,700,000 for the year.

Quotations for fibre have continued on the downward trend. As a result, production slackened perceptibly. The total export for 1929 was 2,476 tons comprising stocks left over from last year. In view of the instability of the market for Mauritius Hemp, attention has been drawn to the possibility of utilizing the local fibre for packing sugar, in lieu of the jute sack imported from India. Capital has been provided from private funds in support of this new venture and assistance granted by the local Improvement and Development Fund.

In relation to fruit canning and preserving, an important move forward has been made and the scheme is now offering fair prospects of success. Private capital to the amount of Rs. 150,000 has been contributed and an equal sum is loaned by the Improvement and Development Fund. Pineapple plantations have been started on a scale commensurate with the new industry and, in the manufacturing processes, expert advice will be available.

There are seven distilleries at present at work in the Island, several of them well equipped installations producing alcohol for human consumption and for industrial purposes. The rum production in 1929 amounted to 896,490 litres.

As a consequence of the general depression in trade produced by the low prices for sugar and the concomitant falling off in the general revenue of the Colony, efforts are being made in various directions with a view to exploring possible sources of activity and production capable of helping in the maintenance of the large and increasing population of the Island. The production of food crops is at the same time receiving attention and various attempts made at growing rice, the staple food of the community. It is not yet possible to ascertain to what extent success will meet all these efforts.—(*July*, 1929 *to April*, 1930, *Progress Report contributed by M. Koenig.*)

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Tanganyika.

The Assistant Entomologist to the Tanganyika Department of Agriculture, Mr. W. V. Harris, informs us that the export of beeswax from the Territory for the period January to June, 1930, was 1,079 cwts. valued at £6,939. The figures for the corresponding period of 1929 were 3,651 cwts. valued at £26,628.

This marked decline is attributed to the prolonged rainy season this year following on the excessive drought of last year which weakened the colonies considerably. The collection of wax has been delayed also by the rains. It is doubtful if last year's total of 6,721 cwts. valued at £48,149 will be reached.

The local price of beeswax has continued to decline in common with that of agricultural produce generally. The present demand for honey for local consumption has, however, done much to counterbalance the effect of the low price of wax and collection of honeycomb and preparation of wax is active.

Propaganda work at present being carried out by the Department of Agriculture for the adoption of improved methods in wax collection and preparation for marketing will, it is hoped, mitigate some of the evil effects of an erratic climate and increase the quantity of wax exported and its value in the future.

The Department has also recently issued revised figures for the 1930 cotton crop. It is estimated that the crop, instead of yielding 34,770 bales, as was anticipated at the beginning of the year will yield 22,000 bales, on account of insect damage. The cotton already picked is reported to be unusually clean and of excellent quality.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Cane Grinding at High Speeds (in Cuba). J. R. Mayo, Jr.

In 1915 Mr. Julio Marcelin in a well-known central in Camaguey Province reached a speed at the mill engines of 80 revs. per min., the rolls of the first, second and third (and last) mills of the two tandems developing a speed of 40, 42½ and 48 feet per min. respectively, then an extremely high grinding co-efficient. At the same time, the extraction compared well with that being obtained by the majority of Cuban mills. Later, the author took the matter up, and realized that with the appearance of greater pitch grooving the opening of the mills should be reduced greatly while considering the setting of the crushers and the amount of cane to be ground. In a 19-roll tandem provided with knives he has been able to grind 330,000 arrobas (3683 long tons) obtaining 95 per cent. extraction with 8 to 10 per cent. imbibition, the peripheral speed of the last mill being 42 feet per min., with the third, and fourth in proportion, the three being driven from the same engine. The speeds of the first and second did not exceed 30 and 34 feet, due to the ratio of the gearing and the general arrangement of the equipment. During the last idle season the gearing of the last three mills was modified, so that during the crop the speed of the last three mills was greatly increased, while the settings were closed and careful attention given to laboratory reports. At the last mill a maximum speed was attained of 53 feet while grinding 360,000 arrobas (4017 long tons) of cane per day, and reaching an extraction of 95.5 to 95.8 per cent. with 8 to 10 per cent. imbibition, and this in spite of the fact that the first and second mills had to be opened up to give passage to the body of cane. It should be noted here that the power required per 100 arrobas of cane increased ten per cent. with relation to an increase of 25 per cent. in the speed of the rolls, in spite of the fact that the hydraulic pressure had been reduced 25 per cent. So much for the practical results obtained. Looking at the matter from the theoretical point of view, it will be seen that the time the bagasse is subjected to compression when passing through a mill depends naturally on the peripheral velocity of the rolls and the distance covered by the bagasse while subject to such compression. The principal objection raised against grinding at high speeds seems to be that this brings about as a corollary a reduction in the duration of the time of compression, thereby increasing the possibility of re-absorption, and thus giving insufficient time for all the juice to escape from the cells, counterbalancing in fact the advantages obtained from the greater permeability of the blanket due to the corresponding diminution of its thickness. But the peripheral speed is a function of the angular velocity (revs. per min.) and of the diam. of the rolls, the effect of which latter can be seen from the following example: Assuming the bagasse blanket to have a thickness of 12 in. at the commencement of the period of compression, and the distance between the rolls to be ½ in., the peripheral speed and the amount of cane ground being equal in both cases; then the rolls of 36 in. diam. will give a compression interval approximately 5½ per cent. greater than that obtaining with rolls of 33 in. diam.—(*Int. Sugar Jr.*, Vol. XXXII, No. 380.)

* * *

Effect of Cane Trash on Nitrification in the Soil. *

R. F. Garcia, in *Ann. Rept. Insular Expt. Station, Porto Rico*, 1927-28, describes the following experiment. One hundred and fifty pounds of air-dried cane trash were mixed with the surface soil of plots 200 square feet in area. Four pounds of sulphate of ammonia were added to two of the plots, and twenty pounds of ground limestone to another two. To two more were added four pounds of ammonium sulphate and twenty pounds of ground limestone. Four plots, two without trash, were left as checks. Every fifteen days, soil samples were carefully taken from each plot and analysed for ammoniacal nitrogen, nitric nitrogen, and total nitrogen. The production of nitric nitrogen in parts per million of dried soil is given in the accompanying table:—

Effect of Cane Trash on Nitrification.

PARTS PER MILLION OF NO_3 IN SOIL (OVEN DRY BASIS).

Date of Sampling.	*Check plot.*	*Trash alone.*	*Trash and* $(NH_4)_2SO_4$	*Trash and* $CaCO_3$	*Trash and* $(NH_4)_2SO_4$ *and* $CaCO_3$
17th Aug.	3.2	1.6	2.5	1.6	4.1
24th Aug.	5.0	2.1	5.5	1.3	6.1
1st Sept.	4.8	3.5	7.2	3.9	9.0
21st Sept.	6.0	2.6	9.1	2.6	12.6
5th Oct.	6.6	3.0	15.6	3.9	14.6
19th Oct.	7.7	4.5	15.5	5.4	19.6
2nd Nov.	7.8	4.7	20.3	4.5	17.3
24th Nov.	10.6	4.4	25.2	4.2	18.6
14th Dec.	9.8	4.7	33.3	4.9	18.2
29th Dec.	16.0	6.3	33.9	10.7	25.4
13th Jan.	14.4	10.2	42.3	8.7	25.5
26th Jan.	11.9	7.3	24.8	7.8	16.7

The addition of trash lowers the level of nitrate concentration in the soil. The addition of sulphate of ammonia raises the level of nitrate concentration, even though energy-supplying material is added at the rate of 15 tons of air-dried trash to the acre. Under acid conditions, the nitrification of the sulphate of ammonia is slower to start, but reaches a higher level of nitrate concentration at six months time than under nearly neutral conditions.—(*Facts About Sugar*, Vol. XXV, No. 19, 10th May, 1930, p. 467.)

* *Note.*—The obvious implication of these experiments is that trash should not be ploughed under a short time before planting, unless a nitrogenous fertilizer (such as ammonium sulphate) is also added.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

The Manuring of Tobacco.

The peculiar properties required of the dried tobacco leaf, and the great influence soil and added nutrients can exert on these properties, have caused the study of the manuring of the tobacco plant to follow distinct and unconventional lines. The absence or application of nutrient elements other than the classic three may influence the final curing and burning qualities of the tobacco leaf profoundly. Thus, although most crops are considered to react equally to equivalent applications of potassium sulphate and potassium chloride, field tests with tobacco growing on a sandy soil showed that the latter manure increased the average yield by ten per cent. more than the former. Applications equivalent to 20 to 30 lb. of chlorine per acre were used. It was shown that potash was absorbed equally from both manures, but that the magnesia content of the plants receiving chloride was considerably higher than that of the plants receiving sulphate. Apparently the effect of the chloride ion was to increase the availability of the magnesia ion in the magnesia deficient soils on which these plants were grown.

An additional effect of the chloride ion was to increase the moisture content of the leaves, making them resistant to desiccation and 'drought spot' disease. Excess of available chlorine, for example, applications of 40 to 60 lb. of chlorine on sandy, unbuffered soils, will, however, increase the moisture content of the leaf sufficiently to injure the keeping qualities and the combustibility. Further, accumulation of starch and leaf thickening may result.

It is considered that the control of the available chlorine content of the soil is of the greatest importance in determining the commercial value of a tobacco crop.—(*Nature*, p. 111, Vol. 126.)

* * *

The Utilisation of Peanut Shells.

The annual production of peanut shells in the United States of America is about 70,000 tons. Their use as fuel under the shelling plant boilers is unsatisfactory, and many attempts have been made to utilise these waste shells more economically. They contain 3-4 per cent. fat, 6-8 per cent. protein, of which only 70 per cent. is digestible, 18-19 per cent. pentosan, 33 per cent. lignin, 40-50 per cent. cellulose and 1.6-2.0 per cent. ash. The low nutrient value prevents their use as feeding stuff, although they have been mixed with certain concentrated cattle foods as roughage. Incorporations in insulating material, concrete and plaster mixtures have not been successful.

Their relatively high content of pentosan and cellulose suggests that peanut shells could be used as sources of xylose and of alpha-cellulose for paper manufacture. Using the usual method of extraction, the yield of xylose is insufficient to enable it to compete with that prepared from cotton-seed and oat hulls. Moreover, the high ash content is detrimental to their use as a source of alpha-cellulose. It has been found, however, that the ash content can be reduced considerably by mechanical treatment, and can be further reduced by alternate treatments with very dilute acid and very dilute alkali, with intermediate washing at room temperature. Final treatment with 5-7 per cent. sodium hydroxide at 100°C. followed by washing, yields a pulp containing 93 per cent. of alpha-cellulose, which compares very favourably with viscose pulp obtained from wood.

The American Bureau of Standards has attempted to combine the production of xylose and alpha-cellulose by hydrolysing the pentosan and extracting the resulting xylose without injuring the cellulosic fibre of the shell. The method consists in heating the material with water under pressure to remove soluble gums, followed by treatment with cold dilute sulphuric acid and washing to remove most of the mineral matter. The xylose is extracted with 0.16N. sulphuric acid under pressure. The extract is decolourised, concentrated, and neutralized with baryta. Crystalline xylose has not yet been obtained from peanut shells, the product being left as molasses.

The residual fibre may then be treated by the method already described to yield alpha-cellulose.

By the use of this combination of processes it is hoped to produce both xylose and alpha-cellulose at a cost comparable with that of the products of such materials as corn stalks, corn cobs, and bagasse. (*Ind. Eng. Chem.*, p. 903, Vol. 22; *Brit. Chem. Abs.*—B, p. 737, 1930.)

* * *

Cyanogenis in Plants.

The danger of plants containing cyanogenetic compounds to grazing cattle has not resulted in an extended study of such plants and their poisonous inclusions. Even feeding cakes containing prussic acid producing compounds have been used. Although prussic acid has been obtained from plants of some fifty different families, we still remain in ignorance of the function of the original cyanogenetic compound in the plant.

Ten cyanogen containing glucosides have been prepared in the crystalline form and five of these have been synthesised. A review of the literature of the subject has shown that certain of those glucosides are apparently restricted to certain plant families. Thus, amygdalin, prunasin, and prulaurasin are found only in the Rosaceae, whereas other similar glucosides such as linamarin appear to be widely distributed. The concentration of these compounds in the plant appears to vary with the season and the age of the plant. Although no general rule can yet be made, the greatest concentration appears to be in the young growing organs of the plant.—(*Nature*, p. 111, Vol. 126.)

COLLEGE NEWS.

Dr. L. P. McGuire, Banana Physiologist, returned from Jamaica by s.s. *Coronado* on 26th September.

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Mr. G. A. Jones, Assistant Commissioner of Agriculture for the West Indies, sailed by s.s. *Dominica* on 14th October. He will visit St. Kitts, St. Thomas, Antigua, Tortola and Barbados, and is expected to return on 11th December.

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Amongst recent arrivals from England were Mrs. G. Evans, wife of the Principal; Mr. A. G. Howell, College Registrar, and Mrs. Howell; and Mr. J. D. Cleare, Entomologist, Department of Agriculture, British Guiana, who is taking a "refresher course" at the College. They returned from England by s.s. *Carare* on 18th October.

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The following appointments have been made in connection with the College Cacao Research Scheme; Chemist, Mr. J. A. McDonald, A.I.C.T.A.; Geneticist, Mr. F. J. Pound, B.Sc., A.R.C.S.; Physiologist, Mr. E. E. Pyke, B.Sc., A.R.C.S. These officers are expected shortly to take up their duties at the College.

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Our thanks are due to Messrs. Stephens Ltd., for their generous gift of twelve framed wall pictures which have been hung in the College Dining Hall.

* * *

The Governing Body expressed the thanks of the College to Sir Henry Barclay Walcott, K.C.M.G., C.B.E., for his services. Sir Henry ceased to be a Governor on his retirement from the appointment of Treasurer of Trinidad and Tobago.

FORTHCOMING MARRIAGES.

MR. G. G. GIANETTI AND DR. M. F. V. BEATTIE.

The engagement is announced between Mr. G. G. Gianetti, Editor-Librarian, and Dr. M. F. V. Beattie of the London School of Tropical Medicine.

MR. A. PICKLES AND MISS M. C. JARDINE.

The engagement is announced between Mr. A. Pickles, Entomologist under the Froghopper Investigation Committee, and Miss M. C. Jardine.

COLONIAL APPOINTMENTS.

The following appointments have been made recently by the Secretary of State for the Colonies:

June:

Mr. F. W. Thomas, District Agricultural Officer, Tanganyika Territory.

July:

Mr. B. G. Montserin, Agricultural Officer, Trinidad.

Mr. G. Bryce, D.Sc., Deputy Assistant Director of Agriculture, Nigeria.

August:

Mr. R. M. Nattrass, Mycologist, Cyprus.

COLLEGE SESSION, 1930-31.

The College session for the year 1930-31 commenced on the 6th October. The following Students are taking the Diploma Course:—

1st Year:

Messrs. J. M. McEwen and H. C. Miller (Jamaica); Messrs. St. George Cooper and D. Devaux (St. Lucia); Messrs. M. Barcant, B. Darwent and T. E. K. Potter (Trinidad), and Mr. G. C. Bourne (British Guiana).

2nd Year:

Mr. S. A. Schouten (Anguilla); Messrs. J. M. Cave and H. L. Manning (Barbados); Mr. J. Singh (British Guiana); Mr. L. C. W. Greaves (St. Kitts); Mr. L. de Verteuil (Trinidad).

3rd Year:

Mr. G. B. Gregory (British Guiana); Messrs. J. L. Goellnicht and J. de Labastide (Trinidad).

4th Year:

Messrs. C. A. S. Hynam and A. F. Nichols (Barbados); Mr. J. F. Williams (British Guiana).

The Colonial Office Students are as follows:—

Mr. I. W. M. Armstrong-Black, B.Sc., Ph.D. (St. Andrews).
Mr. W. J. Badcock, N.D.A., Dip. Agric. (Reading).
Mr. J. A. Baker, B.Sc., A.R.C.S. (London).
Mr. J. E. P. Booth, B.Sc. Agric. (London).
Mr. J. G. Brash, C.D.A. (Edinburgh).
Mr. M. C. M. Bridges.
Mr. J. N. Clothier, Dip. Agric. (Wye).
Mr. L. E. W. Codd, M.Sc. (S. Africa).
Mr. W. T. Dalgarno, M.A., B.Sc. (Aberdeen).
Mr. J. C. Eyre, B.Sc. Agric. (Stell.).
Mr. W. F. Gwilliam, N.D.A., Dip. Agric. (Harper Adams Agric. College).
Mr. R. E. T. Hobbs, Dip. Agric. (Reading).
Mr. J. G. M. King Dip. Agric. (Wye).
Mr. L. N. H. Larter, B.Sc., A.R.C.S. (London).
Mr. G. D. P. Olds, B.Sc. Agric. (Reading).
Mr. E. Parry-Jones, B.Sc. (Wales), F.E.S.
Mr. T. A. Russell, B.Sc., A.R.C.S. (London), Dip. Agric. (Cantab).
Mr. F. A. Squire, B.Sc. (S. Africa), F.E.S.
Mr. H. B. Stent, M.Sc., A.I.C. (Manchester).
Mr. T. G. Strangeways, B.A. (Cantab).
Mr. R. T. Wiglesworth, N.D.A., Dip. Agric. (Harper Adams Agric. College).

The Empire Cotton Growing Corporation Students are as follows:—

Mr. W. J. M. Irving, B.Sc. (Edinburgh).
Mr. J. D. Jameson, B.A. (Oxon).
Mr. M. F. Rose, B.A. Hons. (Cantab).

The following Students are taking Special Courses:—

Mr. F. Almandoz (Trinidad).
Mr. L. G. Cleare (British Guiana).
Mr. G. V. Wickramasekera (Ceylon).
Mr. J. A. Wirshing (Porto Rico).
Tunku Yacob, B.A. (Cantab). (Kedah State).

The following Students are taking "Refresher Courses":—

Mr. W. H. Beckett, M.A., Dip. Agric. (Cantab)., F.S.S. (Gold Coast).
Mr. E. M. Cook, Dip. Agric. (Wye), (Gold Coast).

SPORTS.

At a general meeting of the Imperial College Amalgamated Clubs held on 7th October, the following Students were elected officers of the several clubs :—

Captain Amalgamated Clubs	Mr. J. N. Clothier.
Rugby Captain ..	Mr. J. N. Clothier.
Association Football Captain	Mr. M. F. Rose.
Hockey Captain ..	Mr. H. B. Stent.
Cricket Captain ..	Mr. R. T. Wiglesworth.
Tennis Captain ..	Mr. J. G. M. King.
Water Polo Captain	Mr. L. N. H. Larter.

APPOINTMENT.

The appointment of Mr. J. B. G. Savory, as Superintendent of Agriculture, Nigeria, who was a Student in residence at the College during the session 1929-30, has been notified by the Secretary of State for the Colonies.

REVIEW.

PRINCIPLES OF TROPICAL AGRICULTURE

By H. A. Tempany and G. E. Mann. *Incorporated Society of Planters, Malaya.* pp. 328.

The scope of this publication will be gathered from the authors' preface, in which it is referred to as a fairly detailed description of the general principles underlying agricultural operations in the Tropics, followed by a discussion of the methods adopted in agricultural practice, without reference to any particular crop.

The first part of the book (pp. 1-136) deals with the factors which limit crop production. Two chapters describe plant growth and nutrition, another the climate of the Tropics; the rest of this portion deals with the properties of the soil, such as its power of retaining air and water, and the plant foods it contains. The last chapter treats of a few other limiting factors, space, temperature, pests and diseases.

The second part of the book (pp. 137-327), is entitled Agricultural Practice, and describes the principal methods available to the tropical farmer for dealing with the conditions described in part I; cultivation, drainage, irrigation, manures, cover crops, rotations, and so on, while a final chapter deals in a general way with the economics of tropical crop production.

From the fact that this work is published under the auspices of the Incorporated Society of Planters, Malaya, it may be supposed that it is intended primarily for the use of the planting community, that is, a class possessing a good general education but with no great knowledge of scientific agriculture. For such, Dr. Tempany's acquaintance with the agriculture of the West Indies and Mauritius, coupled with Mr. Mann's intimate knowledge of Malaya conditions, cannot fail to produce a useful book, and a copy should be in every estate bungalow and in the hands of every newly joined 'creeper.'

But the authors in their introduction claim a wider field for their book than this, no less than the Tropics as a whole. From this point of view, one feels that the work is lacking in perspective, and has been written too much from the point of view of the capitalist producer in what may be termed an insular climate. With regard to the latter, reference is seldom made to the great and important continental areas of India and Africa, with their wide daily and annual range of temperature, and their marked alternation of dry and wet spells. The temperature variation at Bombay is given, but Bombay is not an example of a continental climate.

As regards capitalist production the authors' own views may be quoted: "The ideal agricultural condition for a tropical country, may perhaps be defined as one in which capitalist enterprises, either European or native, predominate, with the addition of a sufficiently large peasant proprietary, which, besides cultivating its own lands, provides a reservoir from which the capitalist enterprises may draw labour for their needs." (p. 317). This quotation will explain what is in the opinion of the reviewer, a tendency to lose sight of the importance and, in many cases, the high standard of indigenous agriculture. If this were not the case, we should not find the statement that "In tropical countries generally, comparatively little attention has been devoted to the working out of systematic rotations," (p. 272) nor should we be told that the advisory work (of an Agricultural Department) comprises "the giving of advice . . . both to government and to planters . . .," (p. 322) for in India and most of our African colonies, the main work of the officers of the Department consists in investigating problems connected with indigenous peasant agriculture, and advising the natives in agricultural matters. In colonies where a planting industry exists, the new Research Institutes mentioned on p. 323 may be expected increasingly to take up advisory work connected with their particular crop.

There are a few slips and misprints: on p. 124, temperatures hitherto given in Centigrade, are recorded as Fahrenheit; the Rothamsted figures on p. 97 might be brought up to a more recent date than 1911. Weeds deserve rather fuller treatment, and it may be doubted whether the statement that clean weeding is still commonly followed in the Tropics (p. 270) is really true. These, however, are trifles and do not alter the fact the book contains much that will interest anyone engaged in the production of tropical crops.

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A gratuitous specimen copy of *Tropical Agriculture* will be sent, post free, to any member of an agricultural society or to any other individual interested in tropical development on application to the Editor, *Tropical Agriculture*, The Imperial College of Tropical Agriculture, St. Augustine, Trinidad, B.W.I.

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.):

		Foreign.	*Preferential.*
		s. d.	s. d.
27th August	....	5 9	9 4½
3rd September	....	5 7½	9 4½
10th September	....	5 5¼	9 4½
17th September	....	5 4½	9 4½
24th September	....	5 3	9 4½
1st October	....	4 9¾	9 4½
7th October	....	5 0	9 4½

American markets at the end of August developed some firmness as a result of the circulation of reports in connection with the recent conference of Cuban and other producers in the United States when proposals involving certain schemes of restriction were made. The strength of the market, however, only proved of short duration and prices have declined to further low record levels. *Messrs. C. Czarnikow, Ltd.* report: "The length of time which must elapse before the economic balance in the Sugar Industry attains normality is at present beyond conjecture. With the present system of Tariffs and Governments' assistance prevailing all over the Sugar-growing World, the operation of the law of supply and demand can no longer be regarded as a speedy corrective to uneconomic values. Furthermore, the fact that the present trade depression is not confined to our article alone, but is being shared by almost every product of the land, leaves the Sugar Beet grower with but few opportunities of cultivating more remunerative crops. Nevertheless, prices have now fallen to levels which in many countries barely cover the cost of harvesting, and there can be little doubt that the continuance of these disastrous conditions must ultimately lead to forced curtailment of production. Should such an eventuality materialise, the sentimental effect of any occurrence such as a reduction in sowing next year must not be overlooked, and it is not improbable that with prices at present levels the market would be quick to respond to the anticipation of an improvement in the future statistical position of the article."

Estimates by Dr. Mikusch of European production in 1930-31 reveal an increase over 1929-30 of no less than 1,564,000 tons, the main feature being a huge figure given for Russia of 2,200,000 tons which accounts for 1,279,000 tons of the above estimated increase.

COCOA.—Since last writing the cocoa market showed no signs of improvement, and with world conditions as they are, commodities being affected in general, an advance in cocoa is hardly probable for the time being.—(*By courtesy of The Cocoa Planters' Association of Trinidad.*)

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COTTON.—The following are the official spot prices in pence per pound of the Liverpool Cotton Association:

	American Mid.	*Egyptian F. G. F. Sakel.*	*Sea Island.*		
			Good.	*Extra fine.*	*Prices paid this Week.*
22nd August....	6·44	10·55	24·50	38·00	7·00
29th August....	6·64	10·45	24·50	38·00	—
5th Sept.	6·48	10·35	24·50	38·00	6·50-7·75
12th Sept.	6·30	10.30	24·50	38·00	7·20-9·00
17th Sept.	6 30	10·20	—	—	—
11th Oct. .... (local)	5·65	—	24·50	38·00	—

Prices for American have again shown a decline in value, the better tone of the market being upset by the Bureau crop estimate which showed a probable production of 14,340,000 bales as against 14,362,000 bales for the August report.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows: 27th August, 4¾*d.*; 3rd September, 4⅝*d.*; 10th September, 3$\frac{15}{16}$*d.*; 17th September, 4⅛*d.*; 24th September, 3⅞*d.*; 1st October, 3⅝*d.*; 7th October, 3¾*d.*

The general tendency of prices on the Rubber Market has been a declining one, further new record low levels being reached. The position with regard to restriction was summed up as follows by *Messrs. Symington and Sinclair* on 27th August: "Malaya, Ceylon and other British producers are willing to agree to some form of restriction of exports, as are also the majority of the Dutch producers. A minority of the Dutch producers are against any scheme and no practical means has as yet been proposed for handling native production in the Dutch East Indies." On 10th September it was announced that no form of governmental restriction of output or of export could be undertaken by Malaya, this decision following on the conference between the Governor of Malaya and the Governor-General of the Dutch East Indies. Put briefly, the Dutch East Indies Government stated that any restriction of output imposed on European owned estates would only serve to encourage native output and that the difficulties of imposing control on native output were, for various reasons, insuperable. On the production side several companies have announced their intention of decreasing output and in one or two cases of ceasing production altogether. There is still a lack of encouraging news at the consumption side of the industry.